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Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JANUARY 1987

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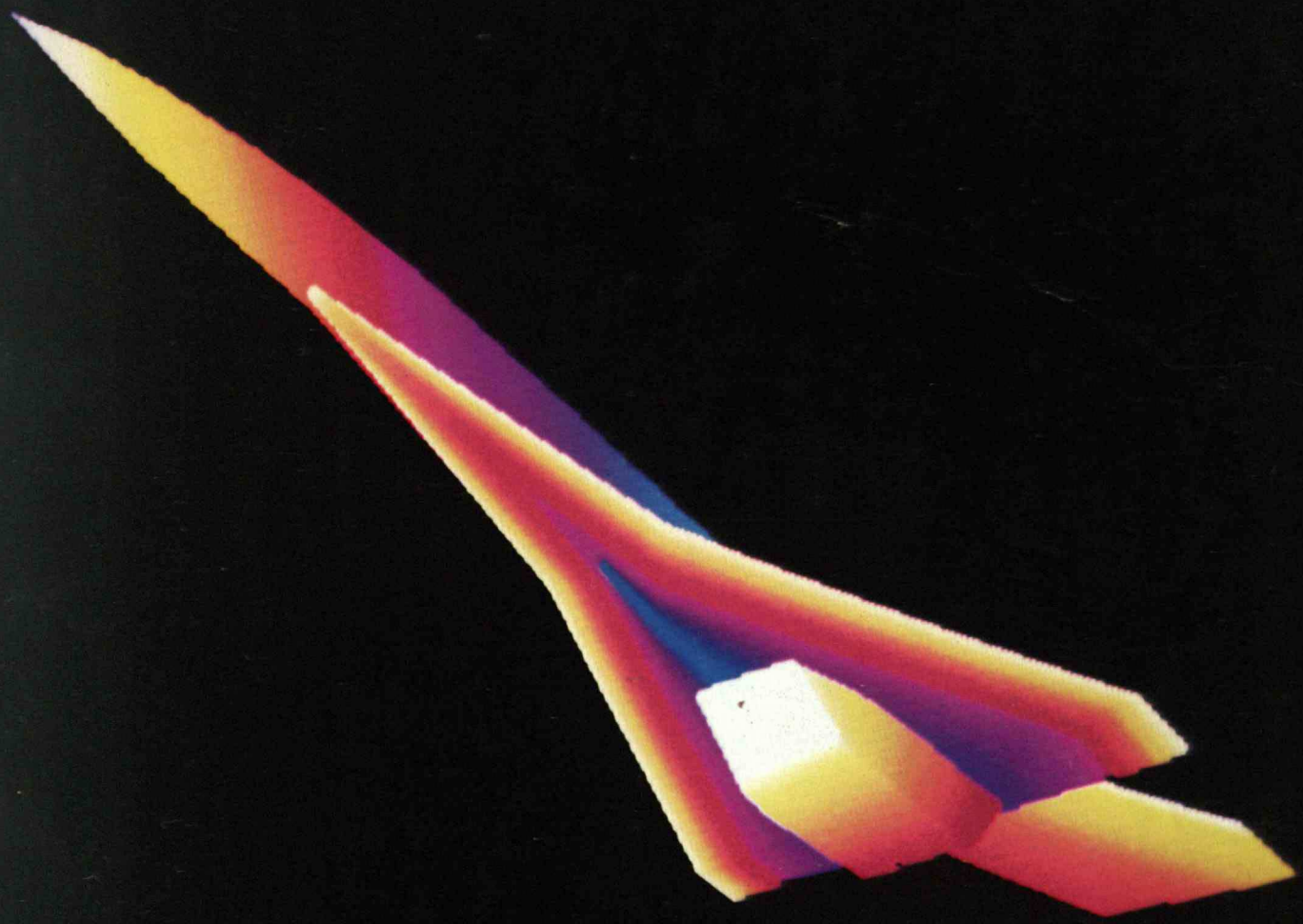

DOES THE SPACE PLANE HAVE THE RIGHT STUFF?

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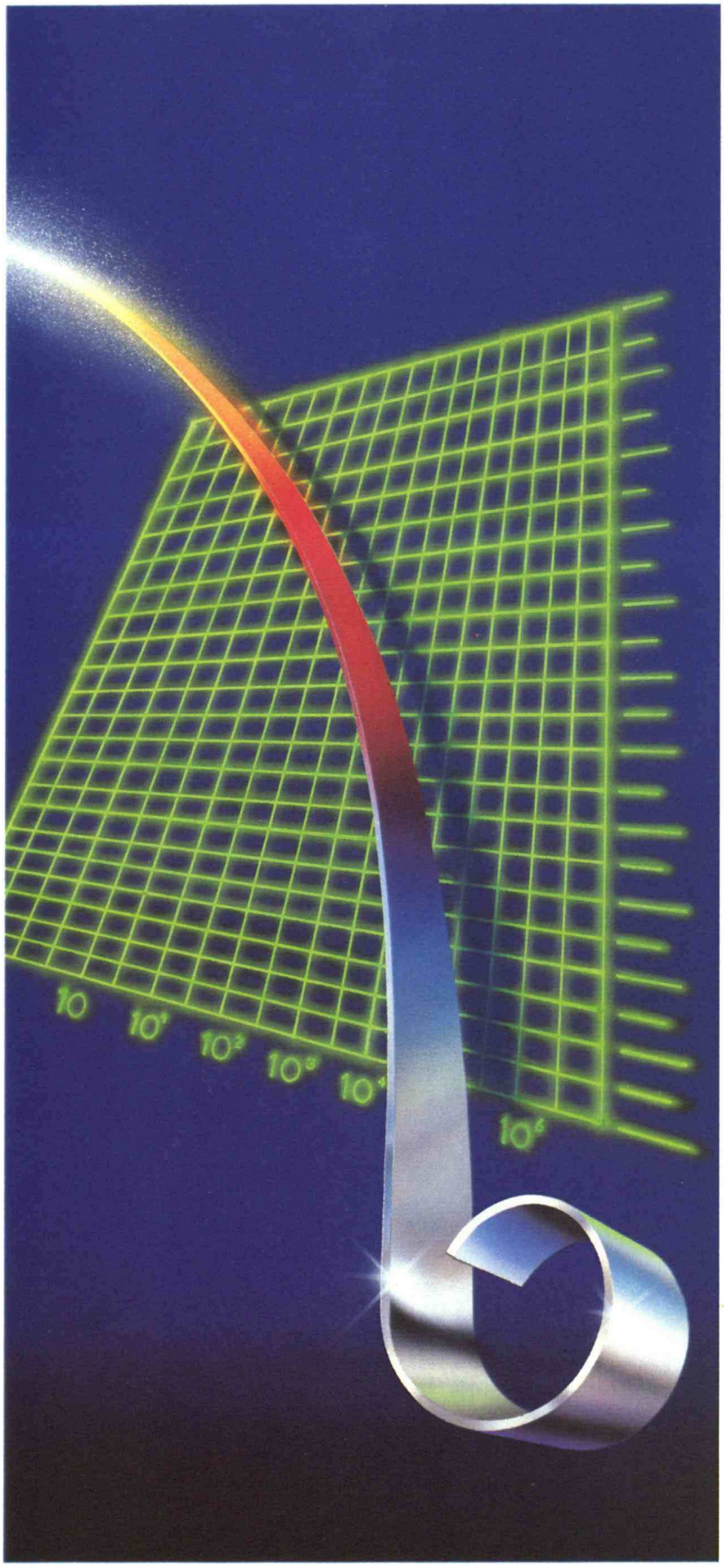


Think Fast

For a hundred years, the aluminum industry has been solidifying molten aluminum into ingot—only to remelt it elsewhere, or to heat it up or cool it down before putting an enormous amount of work into rolling it out flat.

Hmmm.

Wouldn't it be easier just to cast thin metal in the first place and skip the ingot altogether? How? Through rapid solidification.

Powder Metallurgy was the first breakthrough. And now Alcoa scientists are making major strides in two newer technologies:

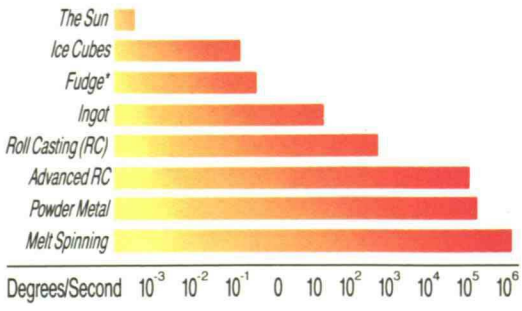
Melt Spinning is a technique to form a continuous ribbon of aluminum alloy by flowing a stream of molten metal onto a rotating drum, where it cools at a million degrees per second.

Roll Casting carries this idea to greater dimensions, and we're working on next-generation techniques that will combine the higher productivity of roll casting with the enhanced properties achieved when aluminum alloys are cooled almost instantaneously.

We're out to make a material difference, and our progress is accelerating.

For a closer look at what we're doing, send for our book, *The Material Difference.* Write to Dr. Peter R. Bridenbaugh, Vice President—Research & Development, Box One, Alcoa Laboratories, Alcoa Center, PA 15069.

Solidification Cooling Rates



*Without walnuts

ALCOA

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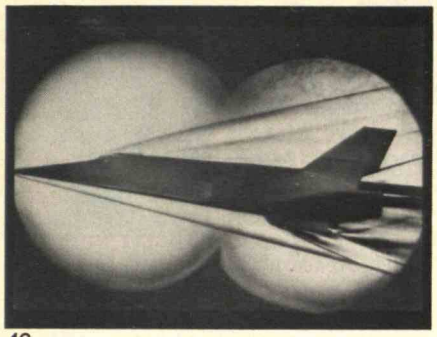

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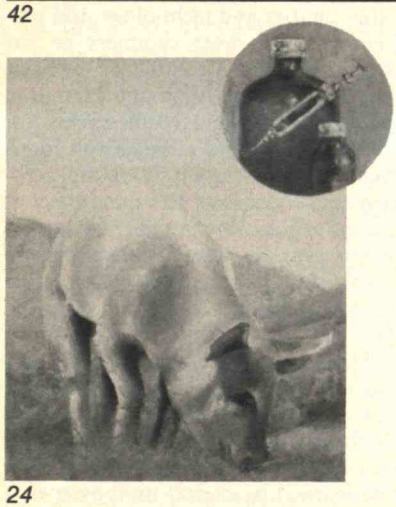

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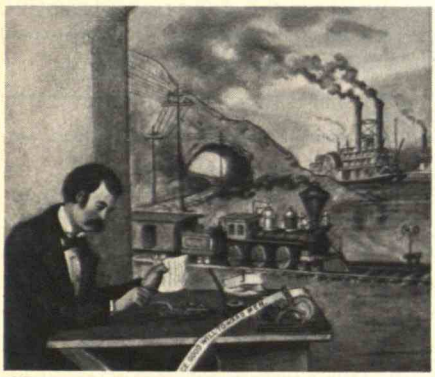

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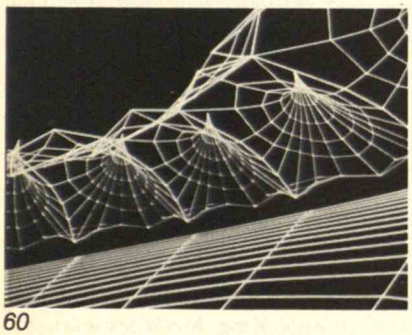

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FIRST LINE

Assessing the Aerospace Plane

THE cover drawing for this issue is far more than mere decoration: it was created by a computer graphics system to reproduce from the contour map on page 50 the temperatures on the skin of a hypothesized hypersonic aircraft flying at eight times the speed of sound at an altitude of 88,000 feet. The points of highest temperature—at the nose and the inlet of the scramjet engine—are shown in white; they are estimated to be at 3,250° F in hypersonic flight. The transition between purple and blue occurs at the 1,400° contour line. Temperatures in a scramjet might reach 3,500° F, compared with the 2,000° typical of today's turbojet engines in cruising flight.

This cover thus emphasizes an important technological issue in developing the aerospace plane—the need for new materials that retain great strength at high temperatures. Most engineers agree with Stephen W. Korthals-Altes in his contribution beginning on page 42: the requirements for propulsion are the most difficult technological challenge in the aerospace plane. But materials technology to meet needs for high-temperature strength in both the airframe and the propulsion system is a close second. The likely difficulty of meeting both these challenges is reflected in Korthals-Altes' estimate that development costs for the aerospace plane will far exceed government estimates.

Stephen Korthals-Altes

Korthals-Altes is unusual among *Technology Review* authors. He received two master's degrees from M.I.T. —at the age of 23— only last June. But his skeptical view of the aerospace plane is well-founded. Korthals-Altes' degrees are in aeronautics and astronautics and technology and policy. For the last three summers he has worked at Hughes Aircraft Co. on basic engineering, at Booz-Allen and Hamilton on information system requirements for the space station, and at Rockwell International on a cost analysis of the aerospace plane, which was also the subject of his master's thesis. Meanwhile, during the academic year he was a consultant on technical issues for the Center for Space Policy in Cambridge.

The computer's rendition of the contour map of space plane skin temperatures also has ancestry at M.I.T. Tom Norton, its creator, has been for several years a research affiliate in the Visual Language Laboratory, and it was during this time that he learned to exploit the power of a computer in the hands of a creative graphic artist. This is Norton's sixth cover for the *Review*.—*John Mattill* □

LETTERS

NAVAJO RELOCATION

There seems to be a media blackout regarding the plight of the Navajo. Thanks for shining floodlights on the hypocrisy of government officials who say the relocation is for the tribe's own good.

I've sent letters of protest to my federal representatives, and I hope other readers have done the same.

C. LEE McCORMICK
Gavilan Hills, Calif.

I would like to point out that what is happening in the Four Corners area isn't an isolated problem. Indigenous peoples all over the world are fighting with those who would destroy them and their way of life in the name of technological progress. It is especially important that technically trained people be aware of this.

BILL HOFMANN
San Francisco, Calif.

I was pleased to read "Moving Those Indians into the Twentieth Century" by Hollis Whitson and Martha Roberge (*July, page 46*) and "It Used to Be Home" by G. Mark Schoepfle, Rose T. Morgan, and Peggy Francis Scott (*July, page 52*). The relocation of the Navajo is an important issue. Our government's treatment of Indians over the years has been appalling, and even people who know this are all too willing to forget.

MARTHA E. MUNZER
Lauderdale-by-the-Sea, Fla.

The July cover story on the relocation of the Navajo is pure propaganda. There is no connection between the relocation and technology.

On second thought, maybe there *is* a connection: the Navajo nation has purchased a large King Air Beechcraft and sent it to an expensive custom contractor

Medical Research–building a healthier future

If you've ever been treated for high blood pressure... heart disease...diabetes...or almost any health problem, medical progress based on research has already touched your life.

Because of medical research, polio no longer strikes in epidemic proportions every summer. Today about three-quarters of patients diagnosed as having Hodgkin's disease will survive five years or longer—as opposed to less than half twenty years ago. Current treatment options for people with heart disease and high blood pressure include medication that helps the body's natural regulators to control blood pressure and volume, enabling the heart to function with less strain.

Scientists are now working on new ways of treating such devastating afflictions as heart disease, cancer and Alzheimer's disease. They are testing new enzyme inhibitors that may control or reverse the late complications of diabetes. Forthcoming breakthroughs in understanding biological processes and treating disease may change the quality and perhaps the length of your life.

Medical research leading to such results takes years of patient, often frustrating experimentation by many different teams throughout the public and private sectors of our scientific community. The tasks involved are not simple.

Advances in research stem from a partnership that includes federal agencies such as the National Institutes of Health (NIH) and the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), universities and teaching hospitals across America, and private industry laboratories. Each partner often works independently to acquire knowledge and test new concepts. They must build on the knowledge developed in all laboratories, and they often coordinate efforts in their search for answers.

Whether an idea originates in a university laboratory or starts with basic product research carried on in the private sector, important findings percolate through the entire scientific community, where each new finding serves as a building block to establish a deeper understanding of what we are and how we function.

Medical research is an expensive process. It needs steady funding for equipment and personnel—even when progress is slow. Government and industry often work with university-based scientists and the medical profession not only in the acquisition of new knowledge and the development of new treatments, but also in funding these advances.

Now more than ever, we all must do our part to help keep the flow of discoveries active and ongoing. If funding for medical research is reduced, major advances in knowledge about some of the most dreaded diseases facing us today could be delayed for years to come.

What can you do?

- *Speak up*. Let your legislators know that you want funding of biomedical research by NIH and other government agencies to be kept at the highest possible levels.
- *Contribute* to voluntary health organizations supporting disease research.

Research-based pharmaceutical companies such as Pfizer are also increasing their financial investment in research. For instance, in 1984 alone, pharmaceutical companies in the United States spent over 4 *billion* dollars on research and product development.

At the same time, we at Pfizer realize the importance of committing more than money to research. As a partner in healthcare, we are continually working to discover new ideas, test new concepts, and turn new understanding to practical and beneficial uses. Now we are working harder than ever to make sure that this nation's medical research effort receives the attention—and funding—it deserves.

For more information on the future of medical research in America, write to Health Research U.S.A., P.O. Box 3852 FR, Grand Central Station, New York, NY 10163.

Pfizer PHARMACEUTICALS • A PARTNER IN HEALTHCARE

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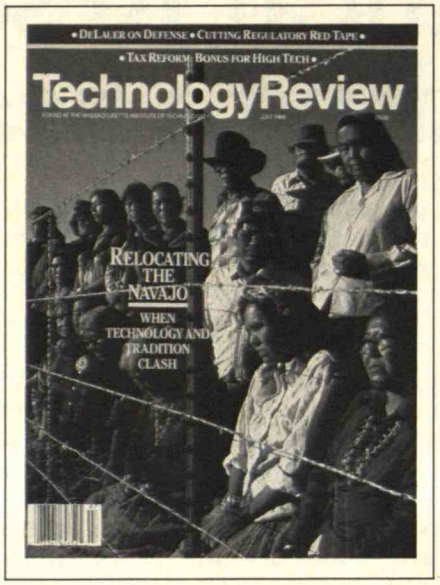


for a luxury interior complete with bar. I don't mean to excuse the white man's faults, but I believe that the problems in the Four Corners area stem from simple greed—on the part of everyone involved.

ROBERT C. CAIRNS
Scottsdale, Ariz.

The pair of articles on relocating the Navajo showed a rather strong bias. The authors of one of them, "It Used to Be Home," were all Navajo employees. They did not interview a single Hopi before dismissing the argument that Congress's action was intended to bring some justice to the Hopis.

The pacific Hopi occupied the land in the Four Corners area for centuries before the Navajo arrived, as is clear from ruins and paintings. When the U.S. government designated a reservation for the Hopi in 1882, the Navajo promptly overran three-fourths of it. The same thing happened in District Six, which was designated for the Hopi in 1943. It is important to keep these historical details in mind.

MATTHEW J. GORDON
Washington, D.C.

The authors respond:

Mr. Gordon invites us to answer the question "Who came first—the Hopi or the Navajo?" We decline to do so. The archaeological information has never been clear. What we do know is that neither tribe owned land in the European sense. Instead, they shared use rights to it. The Navajo never "promptly overran" territory for the simple reason that they had been living on it to begin with.

It is hard to argue with Mr. Cairns's assertion that greed has been a factor in relocation. However, his emphasis on the greed of "everyone" shows that he has failed to grasp the significance of one of the most obvious phenomena of the last 500 years: the assumption by technologically advanced societies that they are entitled to decide the fate of indigenous ones. In many cases the result has been the degradation of native ecosystems and ecologically adaptive cultural knowledge. Indigenous peoples have lost their economic self-sufficiency.

As for the King Air Beechcraft, it did come complete with a custom-installed tribal seal on its upholstery. But the vehicle is often cramped, and it has no bar. Furthermore, all offices and individuals who charter it must pay for the privilege.

TRICKY ARITHMETIC

A common error involving comparison figures shows up twice in "Daedalus Reborn" (*July, page 80*). The new *Eagle* human-powered plane will not have three times *more* range than its predecessor, the *Gossamer Albatross*. It will have three times the range—that is, two times more range. Similarly, the opening sentence should not have said that the distance fom Crete to Greece is three times farther than the distance across the English Channel. It would have been much neater to have said "three times as far."

MARTIN A. GILMAN
Lexington, Mass.

REAL ESTATE IN SPACE

The plan Joel Scheraga proposes in "Curbing Pollution in Outer Space" (*January, page 8*) is misguided and unlikely to be successful. Creating property rights in space would not only reproduce the inequities that already exist on Earth, but it would give rise to new problems as well. For example, would a space "plot" have to be rented for the few seconds it might take a rocket to pass through, or would there be rights of way? What if the Soviet Union bought a sphere of space around Earth and refused to allow trespassers?

Perhaps these problems could be solved by legions of economists like Scheraga. But what is the point? The cause of space trash is our attitude toward nature in general. If this attitude persists, both space and Earth will eventually be rendered useless, property rights notwithstanding.

Nuclear power: victim of referendum and veto.

The military is a prime offender. The Department of Defense (DOD) has polluted shamefully on the ground. Approximately $700 million will be required to clean up just one site—the Rocky Mountain Arsenal near Denver—where the army has dumped chemicals since World War II. In space, the story is much the same. Scheraga mentions Project West Ford, an experiment in which the military launched 400 million copper needles into orbit to enhance the natural reflection of shortwave radio signals. After a first attempt failed in 1961, the DOD performed a second—successful—experiment in 1963, despite international criticism. The debris may still be in orbit. He also mentions the recent incident in which the United States tested a new generation of space weapons by destroying an old air force satellite with a missile. The result was 100 pieces of junk.

The most effective solution to the space-trash problem might be to deny or severely limit the military's access to space. In addition, an international organization could regulate space travel and assess the environmental impact of the few remaining space missions.

DANIEL GROSSMAN
Cambridge, Mass.

CHERNOBYL'S INTERNATIONAL IMPACT

In "Keeping the Cold War Out of Chernobyl," (*July, page 18*), Marshall Goldman ignores the fact that the nuclear accident there will probably have a greater effect in the West than in the Soviet Union. After all, there is no such thing as a public referendum in the Soviet Union.

Sweden had a referendum on nuclear power following the accident at Three Mile Island, and it is rumored that other European countries will hold referendums, too. Now that oil is $10 a barrel, people are especially likely to vote their fears and forgo the development of nuclear energy. Their reasoning would be that if they ever need additional energy sources, they could always buy more Soviet gas, oil, or coal.

As for the United States, we have already legally enshrined the equivalent of a continuous referendum on nuclear energy. Several years ago, a de facto nuclear veto was given to all counties and states within a 10-mile radius of a nuclear plant under construction. They need only refuse to cooperate in planning for emergency evacuation and the plant's licensing will be delayed. No matter how unlike U.S. reactors the one at Chernobyl may be, the accident will encourage anti-nuclear activists to more strongly advocate the use of this veto power.

Of course, every month's delay in licensing will add millions to the ultimate cost of any plant. The plant will then be excoriated as "uneconomical," often by the very folk who have sought the delay. Our nuclear energy program is in danger of being written off despite its proven safety record and obvious environmental advan-

Continued on page 8

Fiber optics: beyond 20,000,000,000 bits/sec.

Summary:

GTE scientists have demonstrated laser modulation and detection at rates as high as 20 gigabits/second. They have developed ultra-small lasers that have light emitting areas as small as 0.2 square microns. They are working to improve the glass fiber itself, as well as to produce optical analogs of electronic switches with the long-range goal of all-optical systems, in which message streams are switched as much as 10,000 times faster than at present.

GTE commercial involvement in fiber optics communications systems dates from the first such installation in Artesia, California, in 1977.

Our scientists developed the system's technology and equipment, and have been contributing to the state of the art ever since.

Current projects deal with increasing the capacity, the versatility, the applications of the systems; longer-term, we are exploring the possibility of all-optical systems.

Faster and faster...

Until recently, optical systems processed digital streams at speeds ranging up to hundreds of megabits per second.

Fast though that may seem, today's carriers are seeking speeds in the gigabits-per-second range. This might even permit the glass to be brought directly to satellite earth stations or microwave towers, for example, for direct conversion of radio signals to light.

Recently, GTE demonstrated the ability to turn diode lasers on and off at rates as high as 20 gigabits per second—about 333% higher than the greatest previously recorded speed.

...and smaller and smaller.

Such speeds require very special lasers. And, as you can see from the electron micrograph at upper right (the head of an ant looking at one of these lasers), it is extremely small.

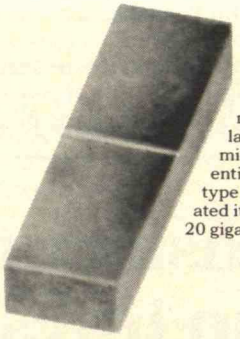
It was constructed on a wafer of InP, by epitaxial growth of a layer of InGaAsP approximately 0.1 micron thick. This was then etched to a mesa shape, and further layers of InP added.

The resulting laser cavity is approximately 0.2 square micron in area, and provides an excellent mate for single-mode glass fiber (fiber with a core of such small diameter that light travels a single path—mode—drastically lowering its dispersion within the fiber).

Switching light with light.

In another project, we are investigating the possibility of ultimately eliminating the electronics altogether by using optical switches.

We are working with materials whose indices of refraction vary with the intensity of incident light—a nonlinear response.



Head of an ant dwarfs a sub-micron-sized diode laser in this electron micrograph. GTE scientists developed this type laser, and have operated it at rates as high as 20 gigabits a second.

Ultimately, if it actually does become possible to switch systems optically, an improvement in speed of as much as 1,000,000% is theoretically possible.

In its brief history, fiber optics has made astonishing strides. At GTE, we are working to continue at the frontiers of this science—to make fiber optics an even more helpful technique to meet the endless needs of tomorrow's telecommunications.

The box lists some of the pertinent papers GTE people have published on various aspects of fiber optics. For any of these, you are invited to write GTE Marketing Services Center, Department FO, 70 Empire Drive, West Seneca, NY 14224. Or call 1-800-833-4000.

Pertinent Papers

High Frequency Modulation on InGaAsP Lasers: R. Olshansky and C.B. Su, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

140 Mb/s Transmission over 30 KM of Single-Mode Fiber Using an LED Source: L.W. Ulbricht, M.J. Teare, R. Olshansky, and R.B. Lauer, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

Tunable Multiplexer/Demultiplexer: Barbara Foley, John Carlsen, Paul Melman, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

Frequency Modulation and Dynamic Lineshape Properties of Single Mode Semiconductor Lasers—Time Averaged Electric Field Autocorrelation Function Measurements: Elliot Eichen, Paul Melman, William H. Nelson, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

Room Temperature Optical Bistability in InGaAsP/InP Amplifiers and Implications for Passive Devices: W.F. Sharfin and M. Dagenais, Applied Physics Letter 46(9), 1 May 1985.

Time and Wavelength Resolved Nonlinear Optical Spectroscopy of a Polydiacetylene in the Solid State Using Picosecond Dye Laser Pulses: G.M. Carter, M.K. Thakur, Y.J. Chen and J.V. Hryniewicz, Applied Physics Letter 46(9), 1 May 1985.

GTE

CONTINUED FROM PAGE 5

tages. However, the Soviets will no doubt go ahead with their own nuclear power program.

LYNN E. WEAVER
Auburn, Ala.

WRITING RULES COLLECTIVELY

In "Squaring Off at the Table, Not in the Courts" (*July, page 36*), Lawrence Susskind and Laura van Dam describe a group decision-making procedure similar to one the Department of Defense has used for over 20 years. When a system or a piece of equipment needs to be reviewed, an initial draft of the specification may be sent out to users, contracting officers, known manufacturers, and those involved in related services. Everyone who responds is invited to a conference to review the specification paragraph by paragraph, and a final draft emerges from this conference.

This procedure has done much to eliminate unnecessary, self-serving, and impossible requirements. Also, those who participate find out that their enemies are human. Unfortunately, though, many military specifications are still written the old way, and these are a cause of excess cost and, often, fraud.

DAVID L. WIESEN
Newark, N.J.

ALUMINUM IN CARS

I was surprised to find that John Mattill's article "Egg-Carton Cars" (*July, page 11*) did not mention aluminum. Like plastic, this material is lightweight, corrosion resistant, and strong. Also, it has been replacing steel in cars and trucks for over two decades. Today's Corvette uses 400 pounds of aluminum, and certain Porsche automobiles use nearly 600 pounds. And unlike plastic, aluminum can be recycled cost-effectively, and nearly 70 percent of it is in fact recycled. The vehicles of the future will probably incorporate *both* aluminum alloys and polymers.

RODNEY E. HANNEMAN
Richmond, Va.

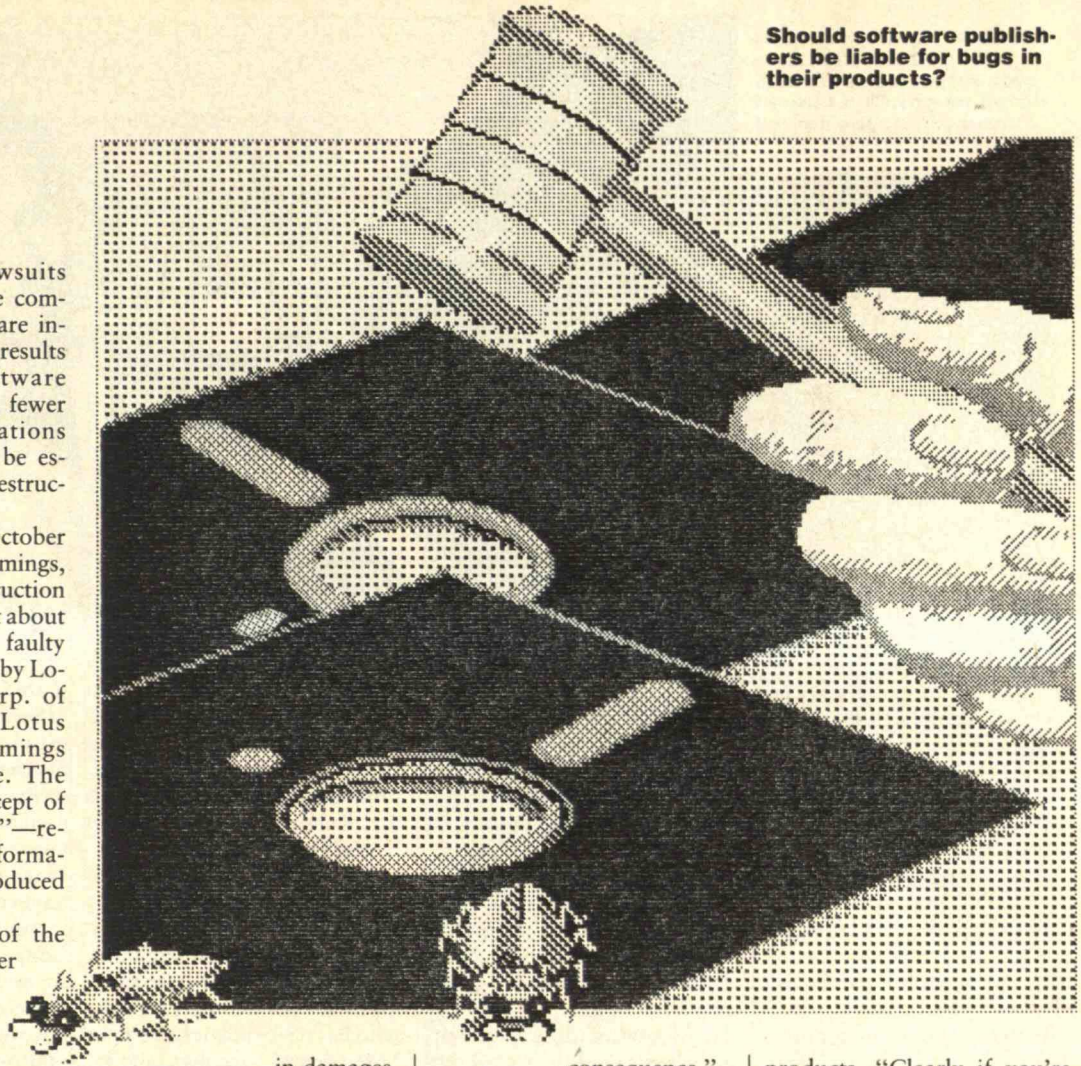
HISTORY OF MONITORING TECHNOLOGY

The electronic ankle bracelets Dee Reid describes in "High-Tech House Arrest" (*July, page 12*) are not as new as she thinks. They were being tested on parolees as early as 1969, according to R.L. Schwitzgebel and R.K. Schwitzgebel, the editors of the book *Psychotechnology*.

H. McILVAINE PARSONS
Alexandria, Va.

Software Liability

Should software publishers be liable for bugs in their products?



Liability lawsuits have hit the computer software industry. The results could be higher software prices, less innovation, fewer programs for applications where liability would be especially risky, and a restructuring of the industry.

In a case filed in October 1985, James A. Cummings, Inc., a Florida construction firm, claims to have lost about $264,000 because of faulty results from a program by Lotus Development Corp. of Cambridge, Mass. Lotus maintains that Cummings misused the software. The suit turns on the concept of "information liability"—responsibility for the information contained in or produced by a product.

Peter Marx, chair of the New England Computer Law Forum, points to two suits that illustrate the complexity of information liability. In one case, now under appeal to the U.S. Supreme Court, lower courts held the National Weather Service liable for the deaths of four fishermen off Cape Cod. The fishermen lost a boat in a storm after a forecast of calm weather. A district court overturned the verdict on a technicality, but let stand the precedent holding an entity liable for information it provides.

In the second case, Jeppeson Sanderson, Inc., of Colorado was held liable for an airplane crash caused by faulty data on flight patterns. Jeppeson Sanderson copied the data accurately from incorrect Federal Aviation Administration information. The company had to pay $12 million in damages.

A software purchaser may pass on information gained from a program to other people, so if companies are held responsible for the information their programs produce, they face almost unlimited liability. But information liability for software is especially tricky to assign, says Geoffrey Berkin, who is associate counsel for Ashton-Tate, one of the nation's largest personal computer software manufacturers. "What constitutes a defect is relative. In software, you can't measure things with a scale and a ruler." Moreover, he notes, "We can't make sure a program is going to be used correctly. I don't think it's fair to say that if we sell you a program we're responsible for every possible consequence."

Ken Wasch, executive director of the Software Publishers Association (SPA), goes further. "There's not a publisher who could certify that a program doesn't have bugs." Indeed, bugs seem almost inevitable as companies rush programs into the marketplace. This haste makes innovative products available months earlier than they would be otherwise. A page-layout program that SPA bought last year proved full of problems, Wasch notes, but SPA still "received enormous satisfaction and utility from the product."

Marx disagrees. "Just because everybody is doing it is no defense." Moreover, he suggests that software publishers already take some responsibility for their products. "Clearly if you're building software for air traffic control you're going to put more controls and precautions into it than into computer games."

Richard Perez, an Orinda, Calif., lawyer specializing in computer law, believes software publishers ought to be forthright about the capabilities and failings of their products. Being honest about a program's weaknesses affords the vendor some legal protection. "There's nothing wrong with having a product that's not quite perfect if you tell people that," he says.

Industry observers agree that software liability may have significant economic repercussions. Among the first repercussions would be a rise in software prices. Right now, the cost of liability suits "is

ILLUSTRATION: OLGA ANTONOVA

not built into software pricing," explains Wasch. Furthermore, Marc Rosenberg, vice-president of the Insurance Information Institute in Washington, D.C., is not aware of any insurer that sells coverage specifically for information liability. Damage claims may be covered under some product liability or umbrella insurance policies, but if suits become common, rates for these policies will skyrocket.

Liability suits might also force software manufacturers to avoid high-risk areas. "Consider the medical programs that are available now—computer-assisted diagnosis," Rosenberg points out. "You're talking about the software designer being sued for medical malpractice." Other software is available or under development to prepare income tax returns, detect weak spots in highway bridges, and diagnose problems in the cooling pumps of nuclear power plants.

Liability would also affect access to venture capital. Private venture-capital investors may choose to put their money where "the risks are more contained," says John Hodgman. He is president of the Massachusetts Technology Development Corporation, a state authority that finances high-risk, high-tech, start-up firms and encourages private investment in such firms. Hodgman expects risk to weigh particularly heavily for large investors.

Much depends on the Lotus-Cummings case, which may not be resolved for several years. "I suspect strongly that the case may be settled out of court," states Wernick. Lotus has to decide "whether to spend umpteen million to defend a case or to settle for somewhat less."

—*Frank Lowenstein*

The New Music Biz

Whether it's the sound track for *Chariots of Fire,* the score for *Miami Vice,* the accompaniment on a Michael Jackson album, the jingles of a television commercial, or the music for a Merce Cunningham dance performance, a great deal of the music we hear today is not made by human beings. It's made by electronic machines. Sophisticated synthesizers are now replacing thousands of real musicians.

Since the first Moog synthesizers appeared on the stages of rock and jazz concerts in the early 1960s, a slow and inexorable technological revolution has transformed the business of making music. Those first electronic synthesizers were primitive. "They didn't attempt to duplicate the sound of another instrument," says Peter Strode, a 33-year-old guitarist who works with synthesizers to produce and compose advertising spots in New York. "Instead, they were used to create a musical sound that no one could produce, sounds you never heard before."

New synthesizers, however, emulate many traditional instruments. Digital samplers such as the Emulator, Kurzweil, the Synclavier II, and Fairlight record sound in binary bits and store it in a computer. One of the oldest digital samplers, the drum machine, corrects timing and makes up rhythmic patterns; it can be operated by a person who has never played a drum. Now digital samplers allow the "synthesists" who play these new instruments to reproduce the sound of nearly every acoustical instrument.

One of the latest technological advances is the musical instrument digital interface (MIDI). The MIDI can hook up all the different synthesizers on the market so that a synthesist can mimic an entire orchestra. "In the past, if I wanted to do a TV spot for a company, I hired a 30-piece orchestra," says Strode. "Now I'll hire two people who each bring a stack of equipment. Sometimes they need 10 people to unload the equipment, and it looks like a NASA control room when it's set up. They'll carry a computer along that can execute the parts, correct the errors, transpose from one key to another, and print out the score."

Synthesizers also permit people with little experience to compose simple, formulaic scores such as many of those used in commercials or television shows. And in many cases recording studios are unnecessary: a synthesist can set up a studio at home. Todd Cooper, who synthesizes music for network sports broadcasts, works alone at home. He records his music on a multi-track tape recorder and then sends the tapes to the network.

John Glazel, president of Local 802 of the American Federation of Musicians in New York, notes that "musical accompaniment is largely done by machines today. Even ballet companies are using electronic music to accompany their performance." This creates a problem for professional musicians, most of whom make their living accompanying singers, movies, TV programs, Broadway shows, and broadcast commercials. Eighty percent of their earnings comes from this work and the residuals they collect on it.

"Almost no one is safe," says Strode, who worked as a guitarist in the Broadway show *Dreamgirls* for several

Guitarist Peter Strode uses synthesizers to compose advertising spots. But he says the technology is putting many musicians out of work.

years until it closed. For the time being, he thinks, guitarists are relatively secure, since synthesizers can't accurately reproduce that particular sound. "So are some classical musicians, since the New York Philharmonic is not about to put a bunch of boxes on stage for its next concert. But as for most musicians—say drummers or electric-bass players—forget it."

Human Consequences

The human consequences of the change appear in the experiences of almost any professional musician. Michael Comins, a 53-year-old New York violinist, worked for 10 years in symphonies and operas, culminating with the New York Philharmonic. Then he became a studio musician instead, and continued working in major studios for 20 years. Now that lucrative and enjoyable profession has declined. "You start being called for less work," relates Comins, who is a founder and chief executive officer of the Recording Musicians Association. "Then you may be listening to the television and notice that a tune you did the last time you were in a studio is now an electronic track.

"What's more," he continues, "the whole field of popular music has changed dramatically. What's selling is punk rock or Michael Jackson and that's all electronic." The change has had a ripple effect, closing down recording studios, putting sound engineers, technicians, copyists, and ancillary personnel out of work. "You find out that the big recording studios—like Columbia Thirtieth Street—have been torn down, and your world has been turned upside down."

A few younger musicians like Strode cope by becoming synthesists themselves, but most, especially older musicians like Comins, have a harder time. It's difficult to break back into the classical world, says Comins, "because major orchestras are like corporations—they don't want to take people past 50, no matter how good they are."

Many musicians feel that the entire culture of music is in danger. "We don't object to the use of synthesizers to create new sounds, sounds human beings can't make," says Glazel. "That's like adding another color to the artist's palette." But he believes that reducing the number of working musicians also reduces "the chances of producing those musical geniuses that make an art."

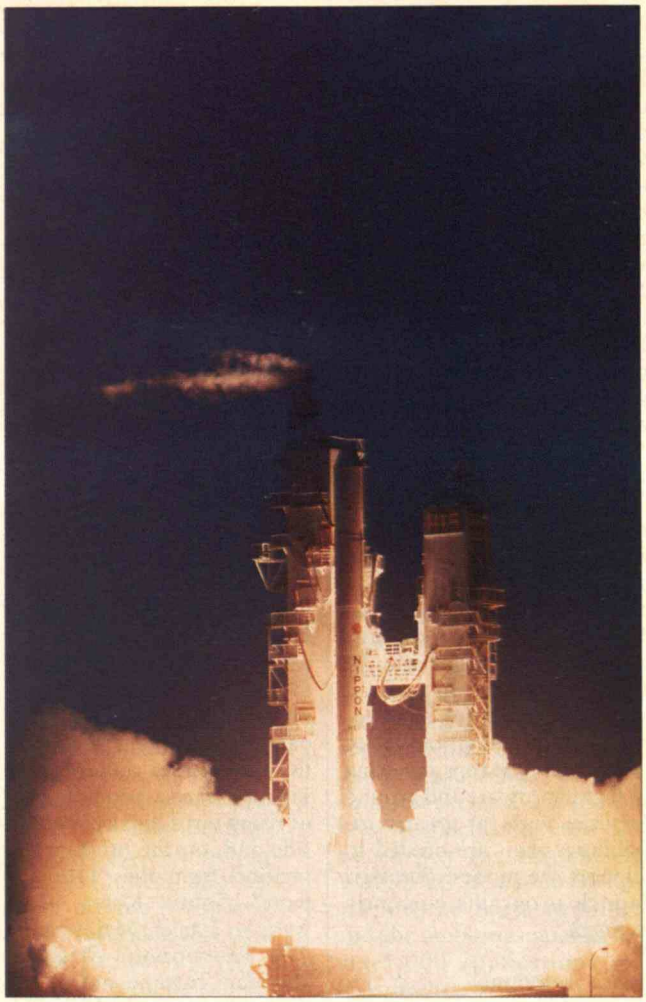
Moreover, Comins asserts that machines could never reproduce some of the nuances of live music. "What makes music exciting and special is the blend of individuals, each adding slight variations and imperfections."

Strode agrees: "I work with synthesizers and make my living at it. And I'd be the first to admit that there is no way to compare synthetic music with real music. It's like comparing apples to oranges. The problem is that when you listen to synthetic music all the time you begin to lose the perception of what real instruments sound like."

Strode believes that these questions are not simply technical or artistic. The decision to use synthesizers is almost always made on commercial rather than aesthetic grounds, he points out. "People don't care whether it's the real thing or not. That means that when someone can save money by using synthesizers rather than real musicians, they'll choose the former."

—Suzanne Gordon

With the launch of an H-1 rocket in August 1986, Japan took a major step toward building an autonomous space program.



Japan in Space

On August 13, 1986, with the launch of an H-1 rocket from the tiny island of Tanegashima, Japan came of age as a major player in space. Until then, the nation's space activity had been modest even compared with European achievements. The successful flight of the H-1 is especially noteworthy in the wake of U.S. and French failures earlier in the year.

As NASDA—the National Space Development Agency of Japan—admits, the earlier N-1 and N-2 rockets were based on U.S. Thor Delta technology dating back to the mid-1950s. Neither the N-1 nor the N-2 could carry more than 800 pounds into orbit, and only two vehicles were launched per year. The H-1 can put a 1,200-pound payload into orbit. More important, H-1 missions are early steps in a 15-year program that calls for space platforms, three new launch vehicles, and an entirely made-in-Japan shuttle that could be operational within a decade.

Like Americans, Russians compare space exploration to

PHOTOS: CINDY PARDY; NASDA (JAPAN)

opening frontiers. Brezhnev once said that "the Soviet Union is the seashore of the universe." But Japanese space officials keep a low profile. One reason is that they don't want to stimulate a foreign backlash—they are following the same strategy they did with cars and electronics. Moreover, they want to keep bureaucrats and politicians at home from interfering. As in the States, not all legislators see the long-term benefits of a space program.

Nevertheless, the Japanese are sending up some signals. The government's Space Activities Commission has asked for $1.9 billion to $3.2 billion as the Japanese contribution to the U.S. space station and $194 million for an unmanned space platform 12 feet in diameter. It wants a smaller amount for an aerospace plane. *Aviation Week* notes that "Japan is investing in flight hardware and ground facilities with far greater capabilities than are needed to support the modest domestic launch programs currently defined."

Space Autonomy

The programs for the near future focus on the H-1 and its forthcoming big brother, the H-2. When it is completed in 1992, this new rocket will be capable of putting 4,400 pounds into a stationary orbit, a significant achievement by any standards. Japan is building a new spaceport on semi-tropical Tanegashima to handle the H-2. The country already has launch and tracking facilities at several locations, the major ones being in the Tokyo area; in Tsukuba, the "science city" 40 miles north of Tokyo; and in Kagoshima on the southern tip of Kyushu island.

The H-2 represents a major step toward an autonomous Japanese space program. According to Hiroyuki Osawa, president of NASDA, "The H-2 incorporates Japan's independent technologies throughout and is designed to serve as NASDA's main workhorse in the 1990s." The push for self-reliance began "in 1980 when Japan's N-2 launch vehicle went haywire," Radhakrishna Rao wrote in the *L5 News*, a journal dedicated to the human colonization of space. "But the real impetus for space independence came with the failure of the broadcasting satellite launched in early 1984," he added. That satellite, which would have transmitted TV programs to remote areas, was built in collaboration with General Electric.

The desire for space autonomy ties in with Japan's apparent economic strategy for the twenty-first century. The Japanese face a potential vise of rising tariff barriers on one side and, on the other, competition from the "little Japans"—South Korea, Taiwan, Sri Lanka, Malaysia. In *The Technopolis Strategy* Sheridan Tatsuno notes that the government is meeting the challenge with a new policy of decentralizing industry, developing state-of-the-art high technology, and encouraging individual initiative.

The push toward autonomy does not mean that Japan will end its cooperation with other nations in space. It intends to continue as an active partner in the American space station, and it is currently training three astronauts. Before the Challenger disaster, a Japanese astronaut was scheduled to conduct 34 experiments in materials processing and life sciences on a 1988 U.S. shuttle flight. Japan still hopes to proceed with this mission, but when (or if) it will take place is anybody's guess.

In any case, Japan will eventually have its own shuttle. "If we don't have launch-delivery capability, our own space program could be greatly affected, even paralyzed," says Tsuneto Nakamura, director of the agency that oversees NASDA. Japan's shuttle will undoubtedly be an improvement over the American version for two reasons. First, the Japanese will learn from our mistakes. But more significantly, the vehicle will not be a horse designed by a committee. Unlike the American shuttle, the Japanese one will be custom-tailored to fit in with their long-term national goals in space.—*Jack D. Kirwan*

MINITRENDS

BIRD TRACKS:
Johns Hopkins University researchers have experimented with using satellites to learn about long-distance bird migration. Birds were fitted with transmitters that beamed information about their location to a satellite. The radios are designed to work with the ARGOS system, in which satellites track and gather weather data transmitted from balloons and buoys. Traditional methods of tracking birds are either very time-consuming or provide only limited data on habitat and migration.

Twelve birds, including a bald eagle and six southern giant petrels, were tracked in 1984 and 1985. The most successful test followed the bald eagle for almost 3,000 miles over eight months, from the Chesapeake Bay area to Pennsylvania, and then to Virginia, South Carolina, and Florida. The record of the eagle's migration provides new insights into the lives of these birds.

Other tests encountered problems, partly because the transmitters are complex and still unreliable. Also, several animals died while migrating. The reason may have been the weight of the transmitter or difficulties with its harness.

BATH & CAR:
A team at the University of Pittsburgh says that water pollutants may be inhaled as vapor in showers. Regulation of public water quality has always assumed that human exposure occurs primarily through ingestion.

The researchers examined the common water pollutant trichloroethylene (TCE) and chloroform, a by-product of disinfecting water with chlorine. They found that when the level of contamination is higher, the diameter of the shower head is smaller, or the water is hotter, vaporization is faster. In addition, the small amount of water that collects at the bottom of a shower seems to produce a substantial effect. Dishwashers and clothes washers may also be sources of exposure to vapor.

A study by Samuel Witz

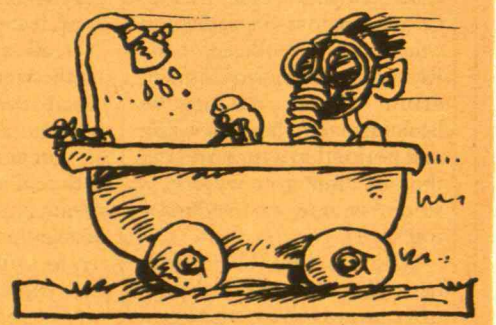


ILLUSTRATION: JON McINTOSH

Dial Down to Jesus

Televangelists have the glamour, but the staple of the electronic church is radio. Radio frequencies are limited, though, and as they fill up, religious broadcasters are reaching for the spectrum space the Federal Communications Commission (FCC) has reserved for local, non-profit, educational programming. One-fifth of that space, which extends from 88 to 92 FM, is already occupied wholly or in part by religious programming, typically fundamentalist evangelical broadcasts.

Dr. Ben Armstrong, head of the 1,200-member National Religious Broadcasters Association, argues that religious broadcasters offer an authentic educational service. Few want to contest the claim. Mainline churches, such as the generally liberal United Church of Christ, have long asserted that limiting access to the reserved educational spectrum on the basis of religion could threaten First Amendment rights.

But as evangelical power grows, distributors, universities, and secular broadcasters are all questioning fundamentalists' claim to the reserved spectrum. At issue is not only a narrow definition of community service, but also local control and diversity of programming.

"Franchising" of public radio stations is burgeoning. VOICE Radio Network and American Heritage Radio (AHR) pioneered this enterprise, which involves recruiting small-town and rural pastors and Christian fundamentalist business-owners to apply to the FCC for educational radio licenses. Both organizations offer boilerplate applications, 24-hour programming, automated station equipment, and advice on how to solicit donations on-air to pay the franchiser. VOICE has 17 stations in operation, 28 more pending, and the ambitious goal of filing 1,000 applications for FCC licenses within the next three years. AHR affiliates have filed hundreds of applications.

VOICE and AHR have similar programming. Brief news bulletins culled from wire services constitute what VOICE advertises as "national and international news from the conservative perspective." The bulletins break up long stretches of what VOICE terms "beautiful, conservative Christian music"—that is, a soft beat and "Biblically sound" lyrics.

Franchising alarms the National Federation of Community Broadcasters (NFCB). The 70 member stations of this organization are typically run by community boards

and others at the South Coast Air Quality Management District indicates a new pollution danger within cars. They looked at toxic-metal and hydrocarbon concentrations inside commuter automobiles on the Los Angeles freeway. They discovered that the concentrations of benzene, toluene, lead, nickel, chromium, and manganese were all three to five times higher than they were outside the automobile.

DR. QUINCY LOSES:

Forensic scientists such as TV's Dr. Quincy may have the facts, but that doesn't always mean people listen. Joseph Peterson of the University of Illinois-Chicago studied the use of lab reports in trials. The reports covered drugs, fingerprints, firearms, trace evidence, blood, and other biological fluids. He found that although the number of crime laboratories is rising and judges are increasingly receptive, scientific evidence is not used any more today than it was 10 years ago.

According to Peterson, prosecutors prefer to depend on the testimony of eyewitnesses and police officers for conviction. On the other hand, they still use forensic evidence since the defendant is often acquitted if they don't. Also, judges seem to rely heavily on forensic evidence in sentencing. It "reduces any doubt in the judge's mind concerning the defendant's guilt, and frees the sentencing judge to give the defendant the maximum prison term."

Laboratory scientists doubt that jurors can understand technical evidence. Prosecutors have more faith in jurors' abilities, but think "they need a capable person to interpret the material for them." Juries apparently do respond to the evidence if it is clearly and cogently explained. A survey of jurors showed "they found scientific experts to be the most persuasive witnesses."

PAPER CHASE:

The National Archives hold more than 3 billion pieces of paper, each a record of some historical event. About 530 million of these records are in danger of being lost to damage, deterioration, or other factors. A National Research Council committee has concluded that the best way to save them would be to seal them in protective materials, treat them chemically, or copy them on microfilm or archival-quality photocopy paper. The committee focused on records that are valuable solely because of what they say, rather than on documents such as the Declaration of Independence that have intrinsic historic worth.

Computers and optical disks are not suitable for preserving records, the committee decided. The technology changes too often, and the materials are too perishable. Magnetic recording tape and disks last perhaps 20 years, and today's computers may easily be outdated before then. But most records will remain intact for centuries if paper clips are removed, sulfur dioxide and other pollutants are eliminated from the air, and other precautionary steps are taken.

In the 1930s, a radio station's ban on Father Coughlin's anti-Semitic speeches sparked protest. Now controversy focuses on evangelism on public radio.

and offer a diverse mix of programming. The NFCB's Pat Watkins says, "We're concerned about the use of a public resource for what usually is a very restrictive point of view." The NFCB calls franchising "spectrum gobbling." It contends that uniform religious programming is not what the FCC had in mind for noncommercial radio serving "the educational and cultural needs of the entire community."

Critics of franchising—religious or otherwise—point to two problems. One is localism: who really runs Mc-Radio stations? Does canned 24-hour programming, interrupted by funding pitches, serve the community as the FCC requires? VOICE itself is clearly concerned that a franchise might not seem to serve local needs: it reassures prospective clients that it is not identified on the programming it supplies.

The second issue is warehousing. Once the FCC accepts a station application, part of the spectrum is set aside—even if no station is built. Because spectrum space is limited, this keeps other stations from getting on. For example, few AHR affiliates are on the air since AHR is undergoing a financial reorganization, but its impact is significant. That's what Marvin Granger, who runs a station licensed by Eastern Montana College, found out. After an AHR affiliate blocked his application for another license, Montana-based Yellowstone Public Radio petitioned the FCC to investigate warehousing. No FCC action is in sight.

Franchising isn't the only way that evangelical sounds enter the public airwaves. Firms that own more than one station are eagerly expanding their domains. Unlike in commercial radio, there's no ceiling on how many public radio stations a single entity can own. Such well-established firms as Moody Bible Institute, Family Stations, and Criswell Bible Institute, all of which produce and syndicate sophisticated programs, are expanding into the low end of the dial.

These changes can threaten existing secular stations as well as create rivalry among the evangelicals. KUCR, owned by the University of California at Riverside, applied to upgrade its status recently and found it had an onslaught of competitors, most of them evangelical broadcasters. A tedious FCC review remains unresolved. In Dallas, long-time community station KNON endured an unprecedented—and expensive—hearing when several religious outfits filed competing applications for its license renewal. KNON lost its license to a Criswell affiliate.

De Facto Networks

The conflict goes sky-high with proposals for satellite-fed national networks on the public spectrum. Along with its 11 stations, the Moody Bible Institute has 32 translators—low-power boosters that carry a station's signal a few miles further. Last spring, Moody asked the FCC to let translators receive signals via satellite and microwave. That way, Moody could beam programming from a central location straight to translators—or "satellators"—nationwide.

National Public Radio (NPR) also supplies programming via satellite, but its 300 highly independent public affiliates pick and choose from that programming. NPR urged the FCC to nix the Moody petition, arguing that satellators would permit large firms—religious or not—to establish de facto national networks with uniform programming. Such networks would threaten smaller producers and distributors. The FCC is still deliberating.

Many religious broadcasters themselves fear the advent of satellators because it would give an edge to big-timers like Moody and Family. (Family has 10 stations and 16 translators.) The division on satellators is so deep that the National Religious Broadcasters, which would be expected to lobby the FCC on such an issue, is silent.

And no one's forgotten the infamous "anti-God" petition. In 1974, a petition asking the FCC to refuse educational licenses to evangelicals or any organization with a single point of view elicited a million hostile letters. Over the years the FCC has had to respond to 16 million irate letters on a variety of issues. Fundamentalists continue to mobilize intense pressure campaigns: a thousand readers of the Moody Bible Institute's newsletter responded to a front-page request for comments to the FCC on satellators.

—Pat Aufderheide

Engineers and Immigration

Are American engineers losing jobs to their illegally employed foreign counterparts? Irwin Feerst thinks so. Feerst is founder and head of the Committee of Concerned Electrical Engineers (CCEE) based in Long Island, New York. He and a few other vocal engineers are expressing their concerns to Congress and professional meetings.

These critics say that U.S. firms hire foreign engineers at less than prevailing wages—sometimes even circumventing immigration laws. The American Engineering Association, a loose-knit group of engineers, testified in congressional hearings that companies are "importing foreign engineers as fast as they can process the paperwork."

However, proof of this position is hard to find. The American Society of Mechanical Engineers (ASME), pressed by some members to take a stand, studied the matter and concluded, "There is little evidence to support the contention that the illegal recruitment of foreign engineers poses a significant threat to the employment of U.S. engineers."

One ASME staffer put it more bluntly: "Every year for the last 15 years someone complains that he lost his job to a foreign alien who was hired for a cheaper wage. The facts are, however, that we can't find anything that supports these claims except anecdotal examples and a few case studies."

Feerst, who has run unsuccessfully for the presidency of the Institute of Electrical and Electronics Engineers (IEEE), campaigned in 1986 on the issue of foreign engineers. IEEE recently came out in favor of stricter requirements for foreign students wishing to study engineering in the United States, and Feerst said he had "forced IEEE to take on the problem."

Testifying before the House Subcommittee on Employment and Housing this summer, IEEE representative James F. Fairman, Jr., proposed amending the present immigration certification process. He called for stricter inquiry into whether foreign engineers would compete with Americans for jobs and for making it more difficult to work under exchange or visitor classifications. Fairman pointed out that such action would "provide greater assurance that those granted admission to the United States are not unfairly precluding our citizens from employment opportunities."

James A. Fairman, Jr., has asked Congress to amend immigration laws to protect American engineers.

The stir over foreign engineers is part of the general controversy about the threat immigrants pose to American workers. In October 1986 Congress tightened immigration laws for temporary alien workers who seek permanent employment in the United States. The new Immigration Reform and Control Act of 1986, however, will have little effect on engineers.

Under both the new and old laws, foreign engineers who would not otherwise qualify for immigration face apparently restrictive technicalities. Before they can obtain permanent, legal employment here, the Department of Labor has to certify that qualified U.S. workers were not available. The department must also determine that employing a foreigner would not adversely affect wages and working conditions. At issue is the degree to which these regulations are enforced.

Some contend that U.S. companies bend the rules. For example, to fulfill a legal obligation to publicly advertise job openings, companies may run ads specifying formidable qualifications. Harb Hayre, professor of engineering at the University of Houston and chair of IEEE's Career Activities Council, recalls an "ad in a Wisconsin paper looking for a motor-testing engineer. One of the qualifications was that the applicant had to speak Ukranian."

Documenting Abuses

But how widespread are the abuses? It's a difficult question. IEEE has 270,000 members from over 100 countries, and its claim that U.S. companies are illegally hiring foreign engineers has caused internal debate. IEEE staffer Vin O'Neill says that the organization has begun to document illegal hiring practices. Until this documentation is completed, evidence of such practices will remain scant.

The statistics that do exist show no notable increase in the number of foreign engineers employed in this country. Both Department of Labor and National Science Foundation figures indicate that foreign citizens consistently comprised no more than 4 percent of the engineering workforce. Moreover, the unemployment rate for engineers has not exceeded 3 percent in recent years.

On the other hand, both the number of foreign engineering students and the number of officially naturalized engineers have risen sharply over the past decade. Over 25 percent of the students in U.S. science and engineering departments are foreign citizens. They receive approximately half of all science and engineering doctorates. And foreign students, who are most often funded by their own countries, help to subsidize academic departments. In fact, ASME notes, "Most observers seem to believe that the enrollment of foreign graduate students is advantageous because these students meet the supply needs of our academic institutions and, later, of industry."

According to Robert Weatherall, M.I.T.'s director of career services, keeping foreign engineers is far from the worst thing the United States could do. He believes that a "bigger problem might come from training these bright people and then sending them back. To keep our technological edge, we should keep them here instead."

—Seth Shulman

PHOTOS: BETTMAN ARCHIVE; SALLY GUSTAFSON

SAMUEL C. FLORMAN

A Good Technologist Is a Noble Work

When Prince Charles of Britain spoke at the 350th anniversary celebration of Harvard University, he took the opportunity to criticize U.S. society's strong interest in technology, and in doing so he cited the wisdom of the ancient Greeks. One key sentence from the prince's speech appeared on the front pages of newspapers across the United States: "We may have forgotten that when all is said and done, a good man, as the Greeks would say, is a nobler work than a good technologist."

The linking of Greek philosophy, the British aristocracy, and Harvard in a rebuke to technology provides several exquisite ironies worthy of thought.

Let us begin with the Greeks. It is true that in the first half of the fourth century B.C. many Athenian intellectuals held technological activity in low regard. Plato made this clear in several of his dialogues, and his contemporary, the writer-general Xenophon, stated the case bluntly: "What are called the mechanical arts," he wrote, "carry a social stigma and are rightly dishonored in our cities."

This view, however, was held by a limited group of people at a particular moment in classical antiquity. Two hundred years before Plato, the Athenians authorized Solon, their chief magistrate, to initiate economic and constitutional reforms. Plutarch tells us that Solon, as part of his scheme to design a stable and prosperous society, "invested the crafts with honor."

"At that time," Plutarch says, "work was not a disgrace, nor did the possession of a trade imply social inferiority."

A century and a half later, technology was still treated with high regard. Sophocles confirmed this view in the famous chorus from *Antigone*: "Wonders are many, and none is more wonderful than man . . . turning the soil with the offspring of horses, as the ploughs go to and from year to year . . ."

By Plato's time, however, the situation had changed radically. High culture had come to Athens with a vengeance. The ideal Athenian citizen cared for his body in the gymnasium, reasoned his way to truth in the academy, gossiped in the agora, and debated in the senate. The design and manufacture of material things was not deemed worthy of a free man's time. We may well wonder if this patrician attitude did not contribute to the ensuing decline and fall of the Athenian state.

> ***An anti-technology bias seems to have tainted Harvard's 350th celebration.***

Platonic scorn for technology has returned to haunt engineers from time to time, nowhere more virulently than among the upper classes of Great Britain. There, the landed gentry traditionally considered engineering to be an occupation suitable only for the lower classes. This prejudice was reflected and nurtured in the nation's great universities. Although engineering science began its rapid development in the mid-eighteenth century, a program in "mechanical science" was not introduced at Cambridge until 1890. The British parliament belatedly began to provide funding for technical education at about the same time, mainly through grants to city universities.

By then, the *Ecole Polytechnique* of France was more than a century old. Conceived under the French monarchy, founded by the revolutionary government, cultivated by Napoleon, and supported by every government thereafter, the *Ecole* was testimony to a view of human affairs very different from that of the British establishment. It represented the view that technology was central to high civilization and deserving of the attention of society's elite. At the end of the nineteenth century, Britain, cradle of the Industrial Revolution, found itself overmatched in science-based technology by France, Germany, and other European nations. It can be argued that the decline of Britain as a world power had its roots in that lapse.

Upper-class prejudices against technology were exported from England to the United States and found a home in Harvard and other eminent universities. The founders of American engineering education—at the United States Military Academy and Rensselaer Polytechnic Institute—fashioned their programs after the French model. "Applied science" was grudgingly introduced at Harvard in 1847 with the founding of the Lawrence School (endowed by a manufacturer of woolen goods). However, that school graduated only 49 men before the Civil War, and this according to an engineering educator "in the face of an unconcealed disdain on the part of the regular faculty."

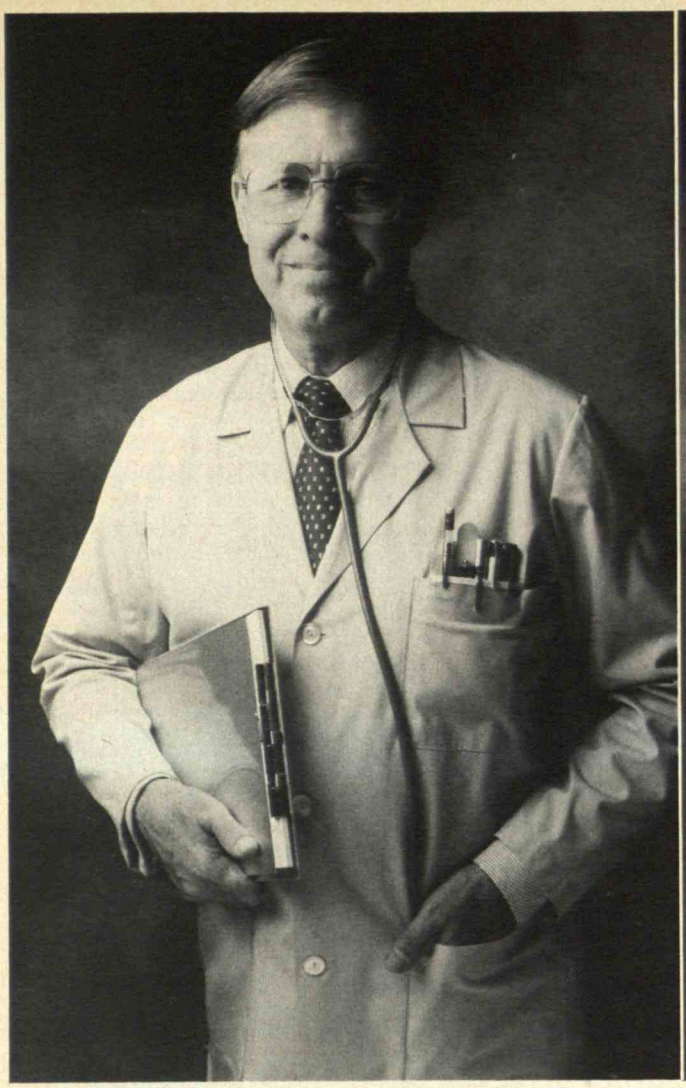
Such disdain doubtless convinced the founders of M.I.T. of the need for their institution. If the U.S. had been guided by Harvard's concept of higher education, we might well have followed Athens and Britain into the backwaters of history.

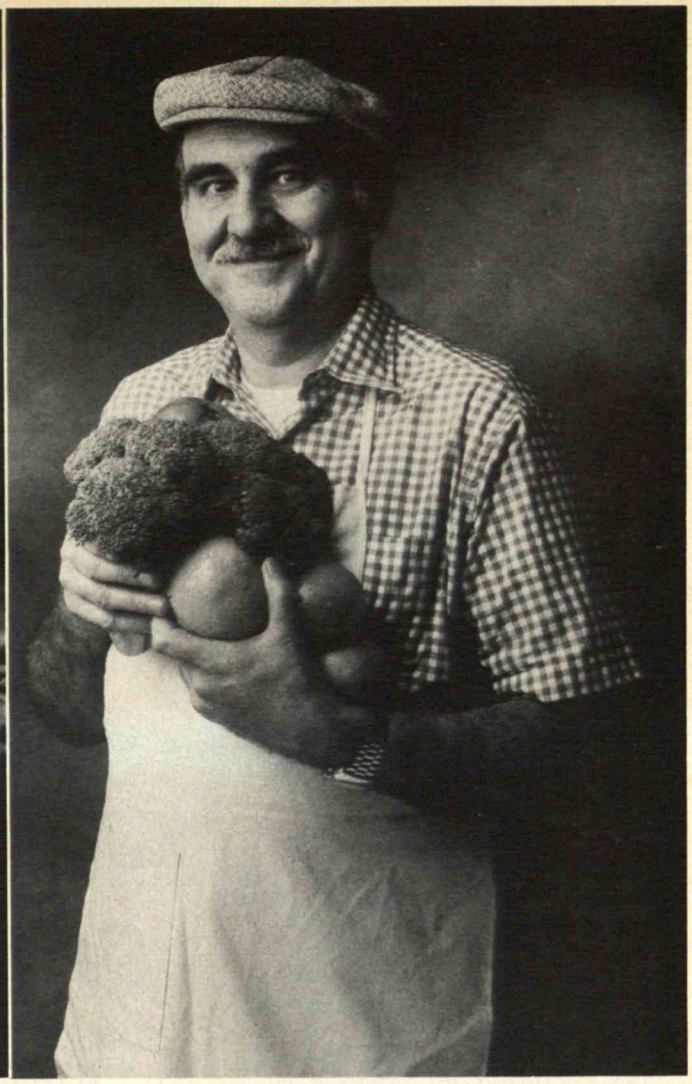
In all the articles about Harvard that appeared during the week of its celebration, in all the praise for its various departments and for its outstanding graduate schools of business, government, law, and medicine, I was surprised to see no mention of the university's lack of attention to engineering. In 1985 Harvard awarded only 38 undergraduate degrees in engineering science, plus 6 master's degrees and 8 doctorates. If M.I.T. were not its close neighbor—making the development of its own engineering school somewhat superfluous—Harvard would be viewed as a seriously flawed institution.

The appearance of the Prince of Wales at Harvard's celebration, and his harking back to Greece in warning against the evils of technology, made for a pleasant tableau and provided a laudable endorsement of scholarship and virtue. But the occasion also evoked memories of aloof philosophers, complacent aristocrats, and haughty academics, people whose view of the world has been needlessly fastidious and dangerously shortsighted. □

SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF ENGINEERING AND THE LIBERAL ARTS, THE EXISTENTIAL PLEASURES OF ENGINEERING, *AND* BLAMING TECHNOLOGY.

ILLUSTRATION: BRUCE MADDOCKS





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MARSHALL I. GOLDMAN

Opening the Soviet Hothouse: How Far Can Gorbachev Go?

WITHOUT doubt, Mikhail S. Gorbachev is one of the most daring leaders the Soviet system has ever had. His last-minute call for a summit meeting at Reykjavik and his willingness to scrap many of the Soviet Union's long-held positions on arms control are only two instances of his readiness to take risks. His recent decision to legitimize joint ventures with foreign companies and break the monopoly of the Ministry of Foreign Trade on imports and exports is yet another example of this inclination to question long-held dogmas. As of the first of this year, the Soviet Union's 21 ministries and 71 of its larger enterprises, such as the Togliati Automobile Assembly Plant, can deal directly with their foreign counterparts instead of having to use the ministry as an intermediary.

Gorbachev and his advisors have been very explicit about why they are exposing their economy to more foreign interaction. For years, the Soviet leaders boasted that their system was protected from the speculation and intrigue of foreign markets and competition. When Western economists pointed out that isolationism was hindering the ability of Soviet industry to compete internationally, Soviet economists would wrap themselves in a variety of excuses. Most popular was the line that economic shortcomings were inevitable after the massive destruction the Soviet Union suffered in World War II.

But now, after four decades with inadequate improvement and the gap between Soviet technology and the rest of the world growing, Gorbachev has decided the old excuses are no longer valid. The economic success of once insignificant powers such as Japan and South Korea must be particularly discouraging to the Soviet leader. These countries, after all, have developed industrial skills that far surpass those of the Soviet Union. Now even China has begun to stir, raising the possibility that within a few years it might outperform the Soviet Union in some technological arenas.

It was the sudden collapse of world oil prices that highlighted how bad the Soviet Union's position had become. Until 1985, petroleum and natural gas accounted for 80 percent of the Soviet Union's earnings from non-military exports. Thus, when the price fell from $30 to $10 a barrel, the Soviets sought desperately for products to make up the difference, but none could.

Gorbachev's new policy of encouraging trade with the West has its risks.

Even when the Soviets cut prices on their manufactured goods, few were willing to buy them. In 1983, for example, the Soviets were able to export 111,000 heavily subsidized automobiles to Western Europe. But in 1984 and again in 1985, the total fell below 90,000. Soviet automobiles were no match for Asian imports. Other manufactured items sold no better. It became clear that the Soviet Union was producing little of world-class value.

Last August, Soviet authorities finally acknowledged that the monopoly of the Ministry of Foreign Trade over imports and exports was a terrible disadvantage. The monopoly did allow the Soviets to play off one potential seller against another to obtain a lower price, but the ministry's involvement added an extra stage to the negotiating process. More often than not, the needs of the Soviet buyer exceeded what the ministry was willing to pay for. Negotiations on contract terms would often drag on for two to three years—a stretch equal to the entire life cycle of many high-tech products.

The lack of direct contact between buyers and sellers also severely limited product service and made the transfer of advanced technology—where users need guidance—all but impossible.

Most Soviet economists assume that joint ventures with foreign companies will finally provide the Soviets with the know-how to master high technology in fields such as specialty chemicals, energy, and computers. What these economists don't seem to appreciate, however, is the difficulty of transplanting such know-how. The Soviet infrastructure is simply not set up to handle sophisticated processes such as manufacturing semiconductor chips, since it lacks both the technical knowledge and the cheap labor to make them.

What Soviet leaders must come to understand is that joint ventures can only be successful if they involve hard work and sweat. Joint ventures have worked well in Asia because the workers and managers were initially prepared to work intensively at menial tasks. The switch in technology from heavy industry such as steel, coal mining, and simple machine tools to labor-intensive processes such as the production of chips and the assembly of computers has suited the Asian workforce. It is hard to see how the Soviet workforce could accommodate itself to such a change. The Soviets seem more suited to macho-type projects, like subway and dam building and the production of steel mills and automobiles. Soviet workers tend to look down on hand labor, especially when the work is being done under foreign ownership.

There is yet another problem: Western business owners see joint ventures primarily as a way of obtaining access to Soviet markets. As a result, foreign investors have so far proposed projects that give them that access and involve less sophisticated technologies, such as bulk chemical production, food processing, medical equipment, and fishing enterprises.

The success of these ventures depends on whether the Soviet authorities and their Western partners can work out satisfactory terms and procedures. For instance,

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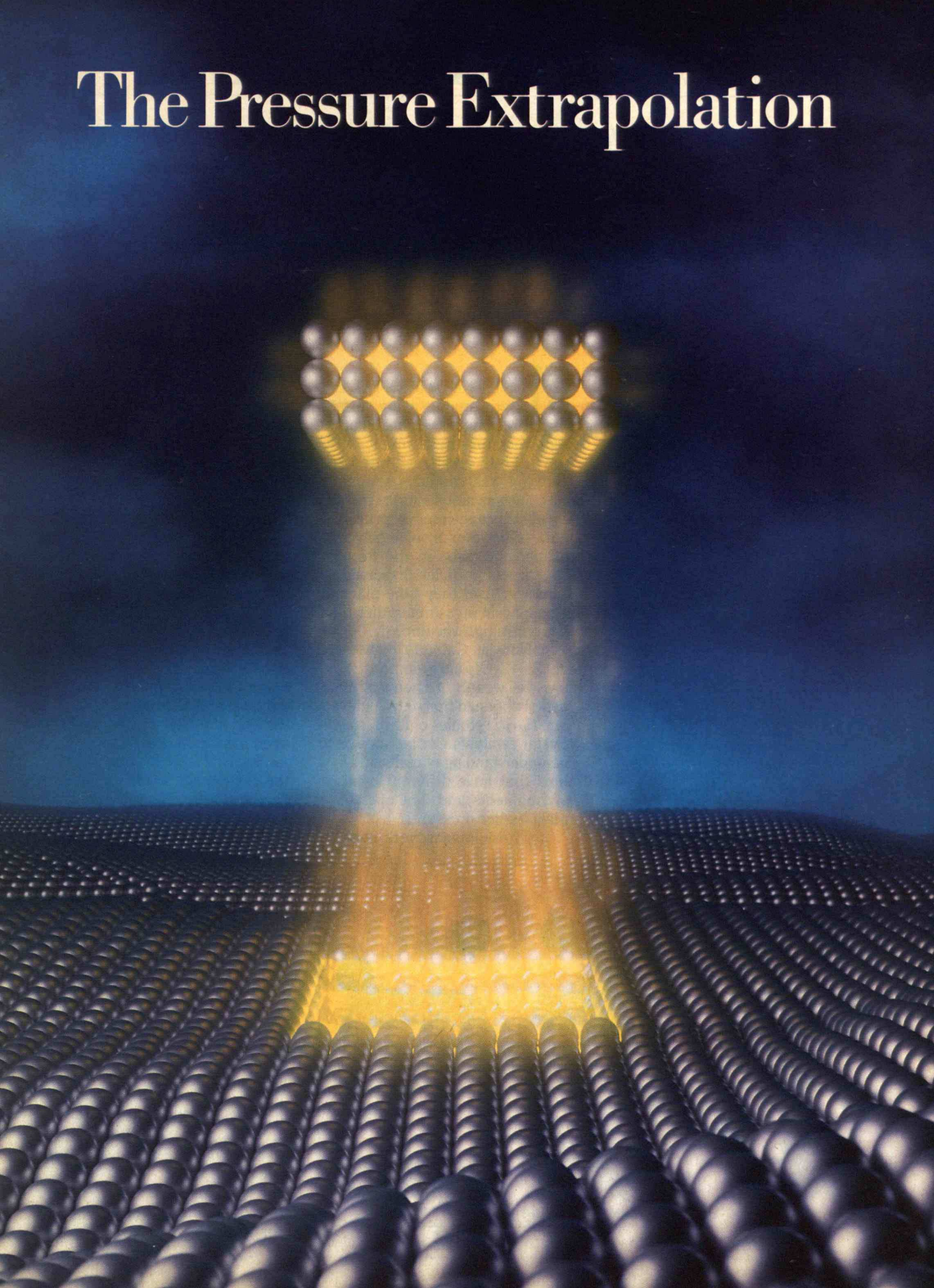
MARSHALL I. GOLDMAN IS CLASS OF 1919 PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE AND ASSOCIATE DIRECTOR OF THE RUSSIAN RESEARCH CENTER AT HARVARD UNIVERSITY.

ILLUSTRATION: JOHN O'SULLIVAN

The Pressure Extrapolation



The Pressure Extrapolation

Modern automotive catalytic converters contain rhodium which promotes chemical reactions to remove pollutants from a car's exhaust. Scientists at the General Motors Research Laboratories have recently made discoveries about one such chemical reaction, the reaction between nitric oxide and carbon monoxide, pointing the way toward new or improved catalysts.

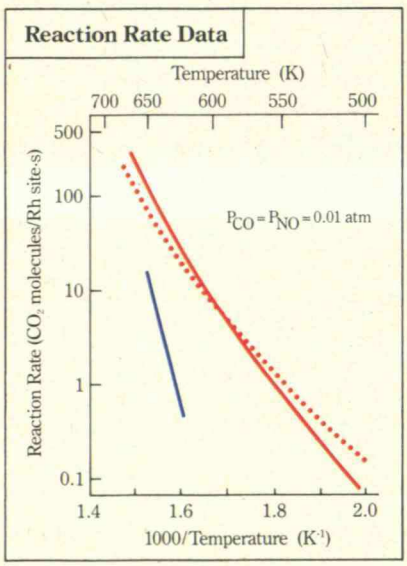


Figure 1: Rate comparisons for the NO-CO reaction. Measured data over single crystal Rh(111) (solid red line) and over supported Rh (blue line); model predictions (dotted red line).

Figure 2: Schematic representation of the elementary intermediate steps for the NO-CO reaction.

MOST FUNDAMENTAL catalytic studies using surface science techniques require an ultrahigh vacuum environment (10^{-13} atm). They are best suited for studying well characterized materials, such as metal single crystals. Catalytic reactions of practical interest, however, involve polycrystalline materials, in the form of small metal particles dispersed on supports. And they take place at atmospheric pressures rather than in an ultrahigh vacuum.

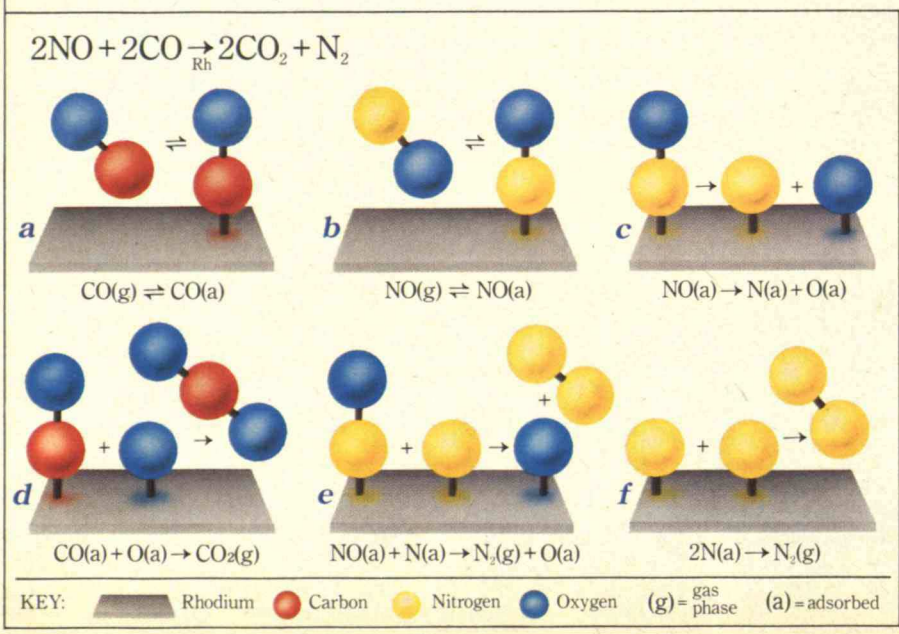
Now Dr. Galen B. Fisher and Dr. Se H. Oh have demonstrated how the wealth of chemical information obtained from ultrahigh vacuum (UHV) studies of ideal, single-crystal catalysts can be applied to the understanding of real-world systems that have different catalyst environments and that operate at much higher pressures.

These researchers concentrated their studies on the many chemical reactions that occur in modern automotive catalytic converters. One such reaction is the reduction of nitric oxide (NO) by carbon monoxide (CO) over a rhodium (Rh) catalyst to yield carbon dioxide (CO_2) and nitrogen (N_2) (Figure 2).

Dr. Fisher used various surface science spectroscopies in ultrahigh vacuum to study all of the elementary reactions over a rhodium single crystal [Rh(111)] that might be involved in this specific reaction. Over several years he measured the rates and determined the activation energies of each of these reactions. For most of these reactions, this was the first time these parameters had been measured. Based upon these results, Dr. Fisher hypothesized that the elementary reactions shown in Figure 2(a-f) were the significant steps involved in the NO-CO reaction and that nitrogen recombination and desorption (Figure 2f) was the rate-controlling step on Rh(111).

Dr. Fisher and Dr. Oh also initiated kinetic studies of this reaction at realistic reactant partial pressures and temperatures using two different catalysts—one was a rhodium single crystal [Rh(111)], and the other consisted of rhodium particles supported on alumina [Rh/Al_2O_3]. The rhodium concentrations on the support were similar to those used in an automotive catalytic converter. The studies with the single crystal at realistic, high pressures were done in collaboration with Dr. D. Wayne Goodman of Sandia National Laboratories.

At the same time, Dr. Oh devised a mathematical model for this reaction. The model consists



of steady-state conservation equations for the surface species, based on the reaction mechanism and the rate expressions for the individual reaction steps determined in Dr. Fisher's UHV studies. Overall reaction rates could then be computed from the surface concentrations satisfying the conservation equations. The reaction rates predicted by this model, which depend only on reactant partial pressures, are shown in Figure 1 (dotted red line).

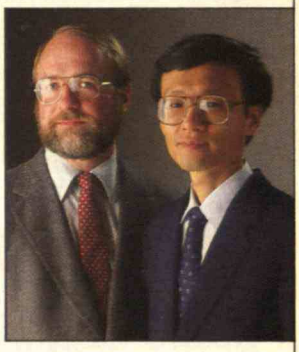
The kinetics of the NO-CO reaction measured over a rhodium single crystal using realistic reactant partial pressures are shown in Figure 1 (solid red line). The agreement with the model predictions indicates that Drs. Fisher and Oh had correctly identified all of the intermediate reaction steps and confirms that, in this case, nitrogen recombination and desorption (Figure 2f) is the rate-controlling step on Rh(111). The fact that the agreement is so good also indicates that the rates of the elementary reactions measured under UHV conditions are still valid at realistic reactant partial pressures—a pressure extrapolation of more than ten orders of magnitude.

THE KINETICS of the NO-CO reaction measured over the supported rhodium catalyst (Figure 1, blue line), however, were much slower than predicted by the model. In addition, infrared studies have shown that NO is the predominant surface species on the catalyst, suggesting that in this case NO dissociation (Figure 2c) is the rate-controlling step. In fact, if the rate constant for NO dissociation measured under UHV conditions and used in the model is reduced by a factor of 2000, the kinetics of the NO-CO reaction measured over the supported rhodium catalyst are correctly predicted.

The difference between the kinetics of the NO-CO reaction measured over a rhodium single crystal and the kinetics measured over supported rhodium shows that this reaction depends on the environment of the rhodium in the catalyst. The reaction model strongly suggests that the NO dissociation reaction is the reaction step most sensitive to the rhodium environment.

"While our reaction model cannot tell us why NO dissociation is slower on supported rhodium," observes Dr. Oh, "it can help identify the kinds of studies necessary to clarify the origins of such sensitivity." Comparative kinetic studies can also provide useful insights for developing improved NO reduction catalysts. "Our studies have already told us," adds Dr. Fisher, "that one possible path to improving automobile catalysts is to make modifications that increase the NO dissociation rate."

THE MEN BEHIND THE WORK



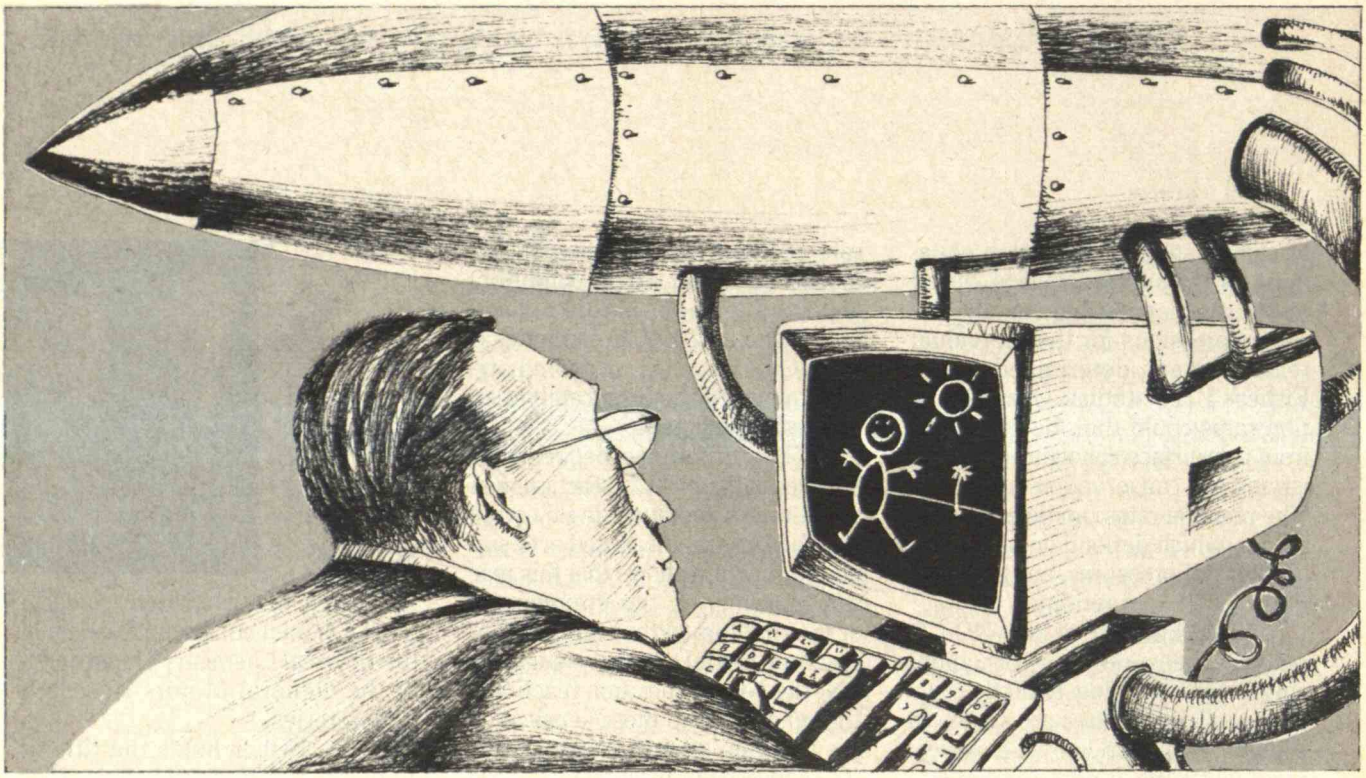
Dr. Galen B. Fisher (left) and Dr. Se H. Oh are both Group Leaders in the Physical Chemistry Department at the General Motors Research Laboratories.

Dr. Fisher holds the title of Senior Staff Research Scientist, and heads the Surface Chemistry and Corrosion Science Group. He attended Pomona College as an undergraduate and received his graduate degrees from Stanford University in Applied Physics. Before coming to General Motors in 1978, he did post-doctoral studies at Brown University and worked at the National Bureau of Standards. Since then, his research has been involved with surface science studies of various catalytic reactions.

Dr. Oh is a Senior Staff Research Engineer, heading the Catalytic Kinetics Group. He received his undergraduate degree from Seoul National University and holds a doctorate in Chemical Engineering from the University of Illinois. Dr. Oh did post-doctoral work at the University of Toronto prior to joining GM in 1976. Since then, he has been involved in measuring and modeling the kinetics of catalytic reactions.

BY JOSEPH WEIZENBAUM

Facing Reality: Computer Scientists Aid War Efforts



WHENEVER I visit West Germany, I am amazed by sights that by now must appear routine to that country's citizens. Some entrances to the nation's highways have covered manholes that are intended to be filled with nuclear land mines in the case of Soviet attack. Every German citizen lives close to nuclear weapons storage facilities.

Across the Atlantic, Americans are, on the whole, not terribly preoccupied about the threat of war. The American experience of war has allowed an "it can't happen here" attitude to grow. But we in the United States are no more distant from the catastrophe than the Germans. If there is war, we shall all die.

All of us must consider whether our daily work contributes to the insanity of further armament or to genuine possibilities for peace. Perhaps without being aware of it, many scientists and technologists exercise their talents in the service of death rather than of life. Today it is virtually certain that every scientific and technical result will, if at all possible, be incorporated in military systems. In these circumstances, scientific and technical workers have a responsibility to inquire about the end uses of their work. They must attempt to know to what ends it will be put. Would they serve these ends directly? Would they personally steer missiles to their targets and watch the people there die?

JOSEPH WEIZENBAUM is professor of computer science at M.I.T.

Technology Not an Evil in Itself

In and of itself, the military is not an evil. Nor is technology evil simply because it has been adopted by the military. But we see our world, particularly its universities and science and engineering facilities, being increasingly militarized. Wars burn in almost every part of the earth, in part serving to test the high-tech weapons of the "more advanced" nations. Probably more than half the world's scientists and engineers work in military institutions or in institutions largely supported by the military.

The computer was born in a time of war, and has since been improved largely to satisfy military objectives. However many civilian uses the computer has, its principal applications are in devices intended to kill people. None of the weapon systems that threaten genocide and whose design, manufacture, and sale condemn countless people to poverty and starvation could be developed without the earnest, even enthusiastic, cooperation of computer scientists and technicians. Without our help, the arms race could not advance another step.

Modern weapon systems rely heavily on artificial intelligence (AI). Many of its technical tasks and problems stimulate the creativity of people working in computer science. Goals such as enabling a computer to see, to think, and to understand spoken language offer nearly irresistible temptations to some among us who have not fully sublimated our playful sandbox fantasies and who want to satisfy delusions of omnipotence. Edward Feigenbaum, a Stanford University professor of computer science and an AI enthusiast, has boasted that "the so-called smart weapons of 1982, for all their sophisticated modern

ILLUSTRATION: EUGENE YELCHIN

electronics, are really just extremely complex wind-up toys compared to the weapons systems that will be possible in a decade if intelligent information processing systems are applied to the defense problems of the 1990s." Research projects in these areas are generously funded, with the money usually coming from the military establishment.

In the United States, the Defense Advanced Research Projects Agency of the Department of Defense is conducting AI research and development through its $600 million, five-year Strategic Computing Initiative (SCI) program. Among its missions, SCI is charged with developing an "autonomous land vehicle," a robotic armored tank in which an AI system will make tactical decisions, and a "battle management system" for an aircraft carrier, in which a collection of AI systems will provide directions for battle.

It is enormously tempting and, especially in AI work, seductively simple to lose or hide oneself in details. Problems can be disguised until they are represented by harmless, innocent-sounding fairy tales. Consider how an M.I.T. student recently characterized his proposal for a doctoral dissertation. He described a child sitting in front of a computer display on which one can see a bear and a kitten playing with a ball. The child tells the computer that the bear should say "thank you" when given something. Then the child verbally tells the kitten to give the ball to the bear. The bear responds aloud with thanks.

Technically, the point of the student's work is to create a computer system that can understand spoken instructions and translate them into a program that is integrated with the computer's basic computational structure.

But to what use, among others, will the student's results finally be put? Perhaps to serve children. But they will certainly have a military application. A fighter pilot will be able to instruct a computer system to destroy a column of enemy tanks upon sighting them. This "pilot's associate system" is the third weapon system SCI is charged with developing.

The psychological distance between the student's conception of his work and the system's intended use is astronomic. Some day a young man, quite like the student, with relatives and friends, will be set afire by a missile directed by the system.

No major weapons could be developed without the cooperation of computer scientists.

All computer professionals should ask repeatedly about the final applications of their work, and whether they are content or ashamed to contribute to such uses.

And they should stop prettifying their language and think and speak plainly about their work. They should recognize, for example, that progress in computer vision will, with absolute certainty, be used to steer nuclear missiles like the Cruise and the Pershing ever more precisely to their targets.

Only our deeply internalized habit of disguising language permits us to speak of weapons and weapon delivery systems, when actually we mean hydrogen bombs and nuclear missiles. Mass-murder machines is how we should speak of them, clearly, distinctly, and without evasion. When one recognizes this, can one work on systems that steer devices of this kind toward living cities?

But computer professionals often assert that the computer is merely a value-free tool that can be used for either good or evil. Scientists and technicians cannot be held responsible for the final application of their work, the thinking goes.

I see this argument concretely manifested in the world-famous Draper Laboratory, which is devoted almost entirely to missile guidance and submarine navigation. Many Draper scientists say that the systems on which they work can help take astronauts to the moon and bring them back as well as guarantee that missiles aimed at a city will actually hit it if fired. How then can they be held responsible for their work's consequences? Fundamentally, they claim, they are powerless to change the world.

This belief is probably the most pandemic mental illness of our time. It is a self-fulfilling delusion offered as a reason for maintaining the status quo. But the attitude, "If I don't do it, someone else will," a thinly disguised version of this disorder, cannot serve as a basis of moral behavior, or else every crime imaginable is so justifiable.

People say that unless everyone behaves morally, arguments such as mine are doomed to impotence. Surely, effectiveness has many degrees. I am convinced I have an effect when speaking to people about this topic simply and directly. That is a modest aim. I want also to address goals such as ridding the world of nuclear mass-murder devices. I want to consider how to reorder the world so that the health of countries does not depend on their ability to destroy their neighbors, but on developing the moral and economic basis for citizens to live in dignity. It has often been said that, if we apply technology—especially computer and communications technology—wisely, in 100 years every person could have everything necessary for a dignified life. But that goal has much less to do with technological advances than with political will.

Personal Responsibility

Some people question what would happen if many U.S. scientists took my advice, inquired as to the end use of their work, and decided they could not in good conscience contribute to that use. Critics point out that elsewhere scientists might not have the freedom to make such choices. My reply is that people are responsible first for their own actions. Furthermore, I believe that such decisions would change the world's moral climate, and dramatically reduce the present atmosphere of confrontation.

Elie Weisel, 1986 winner of the Nobel Peace Prize, once said, "We must believe the impossible is possible." I understand that in two ways. It could mean that "impossible" horrors, such as the Holocaust, can become real. It could also mean that the "impossible" goal of ridding the world of nuclear weapons could be achieved. After all, just 150 years ago it seemed impossible to abolish slavery in the United States. The entire economy of the South was built on slavery. Nevertheless, the impossible came to pass.

World peace is possible, just as it is possible that we will destroy the human race. None of us can achieve the one nor prevent the other alone. Each of us must believe that "it cannot be done without me." □

Genetically engineered products will help us produce more food, but they could harm ecosystems.

Down on the Farm: Genetic Engineering Meets Ecology

BY DAVID PIMENTEL

For thousands of years farmers have benefited from what might loosely be called genetic engineering. By patiently selecting and crossing plants, farmers and breeders have developed crop lines that produce larger yields of vegetables, grains, and fruits; that survive in harsh environments; and that resist pests.

From this perspective, modern genetic engineering might seem to offer farmers little that is substantively different. The new techniques, however, offer the opportunity to transfer genes from one kind of organism to another, such as from a bacterium to a tobacco plant, and therefore open up significant opportunities for creating new agricultural products. Biotechnology can also be used to develop new strains far more rapidly. Whereas it used to take up to 12 generations, or about six years, to produce an insect-resistant strain of tomatoes, gene splicing can cut the time to 4 generations, or two years.

The agricultural benefits from gene splicing and other genetic-engineering techniques could be enormous. Scientists will develop products that will increase food production, reduce fertilizer use, and decrease the need for costly, environmentally dangerous pesticides. But genetically engineered agricultural products could also cause sobering ecological, social, and economic problems. Although the risk is slight, if sound regulations are not developed, engineered organisms released into the environments could create new kinds of pests. And some engineered products will probably only add to a saturated market, putting more small farmers out of business. As we enter the era when the products of genetic engineering leave the lab for the fields, we must head off the potential liabilities with thorough testing and careful decision making.

Genetically engineered farm products will almost surely have a broad range of uses in coming decades. Consider the benefits that will result when organisms such as bacteria, viruses, fungi, nematodes, and insects are engineered to control insect pests, weeds, and plant diseases. The savings could be enormous, since more than one-third of all U.S. crops—worth about $50 billion—are annually lost to pests. Pesticide costs could also drop by as much as $500 million. In addition, some pest outbreaks would decrease if fewer chemicals were used. This is because pesticides now destroy many natural enemies of insect pests, allowing their populations to rebound to alarming sizes.

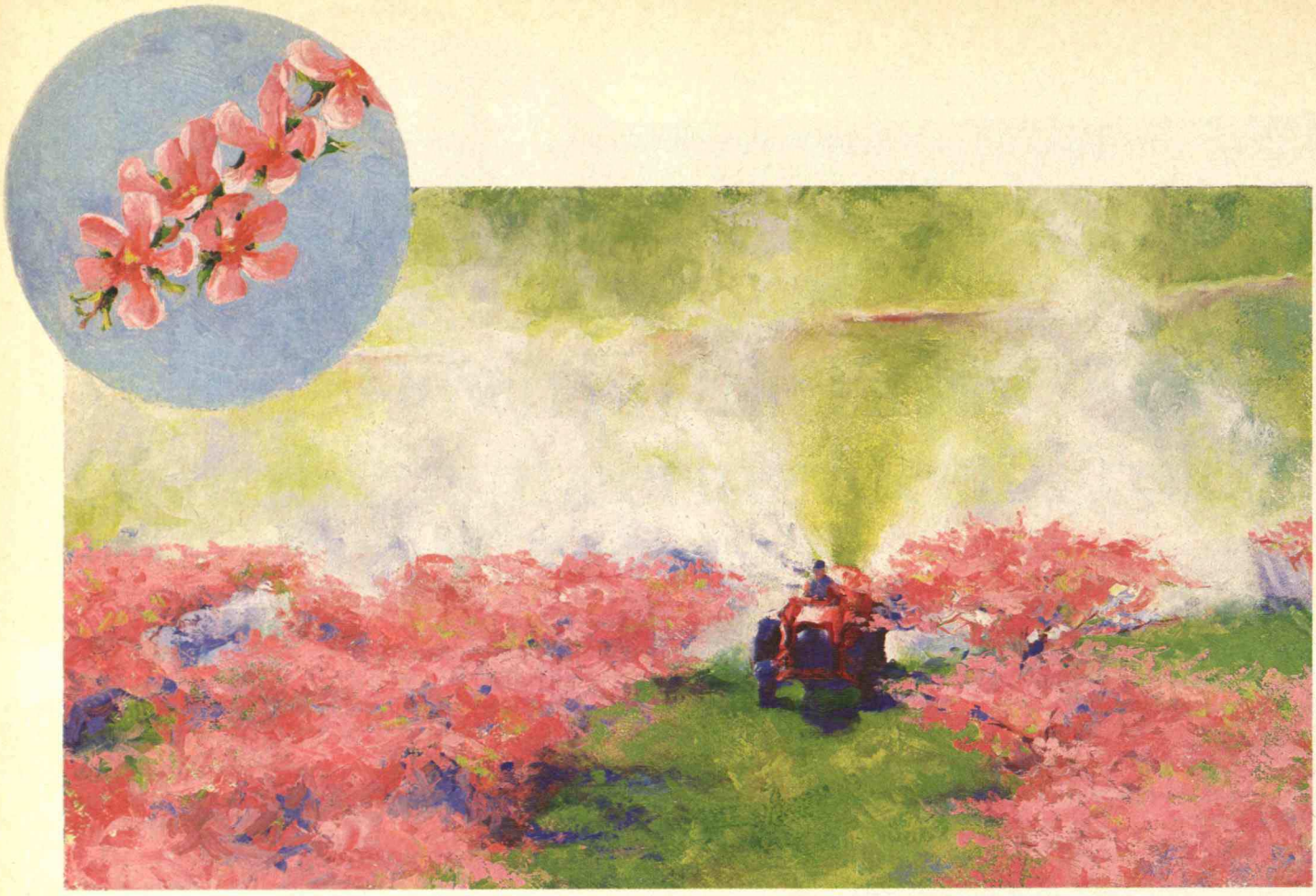
By increasing crop yields, genetic engineering could also reduce the amount of land needed for agriculture. Geneticists expect to be able to use biotechnology to increase the proportion of the crop that can be harvested—usually the fruit—while reducing the proportion of stems, roots, and male sex parts, which are usually not used as food. Thus, the same amounts of land, fertilizer, and pesticide would yield more food. These results would be especially advantageous in areas of the world where arable land is limited.

Biologists have recently shown that they can use genetic engineering to reduce the susceptibility of certain crops to frost. Scientists have eliminated from the bacterium *Pseudomonas syringae,* which inhabits most plants, the genes that produce the pro-

DAVID PIMENTEL is professor of insect ecology and agricultural sciences at Cornell University. He has chaired the Board on Environmental Studies for the National Academy of Sciences, has been an environmental consultant to the Recombinant DNA Committee for the National Institutes of Health, and has served on committees for the EPA and the congressional Office of Science and Technology.

ILLUSTRATIONS: PAUL MOCK

The USDA approved the use of a genetically engineered swine vaccine without going through its established procedure. Fortunately, tests indicate that the live vaccine is unable to threaten other mammals.



tein that serves as a nucleus for ice to form. Spraying enormous numbers of the altered bacteria—known as the "ice-minus" strain—on potatoes, tomatoes, strawberries, corn, and other crops allows the bacteria to outproduce and replace the wild form of *Pseudomonas*. This could extend crops' growing seasons and increase yields.

Geneticists expect that in 20 to 40 years they will also be able to enable basic food grains such as corn and wheat to "fix" their own nitrogen. That is, these plants will be able to transform the nitrogen in the air into a form they can use. This would save farmers $3 billion to $4 billion each year in nitrogen fertilizer costs. Nature has extended this property to only a few kinds of plants, such as peas and other legumes. The task of engineering other plants to fix nitrogen will be enormous, since these plants are genetically far more complex than the bacteria involved in most of today's biotechnology work.

Biotechnology is also being used to develop vaccines and drugs to improve livestock production. The genetically engineered pseudorabies vaccine—developed to control deadly pseudorabies outbreaks in swine—is already on the market.

Genetic engineering will be used to increase the quantities of products such as ethanol that are derived from grain. About 625 million gallons of ethanol, which can be used as motor fuel, are produced by fermenting grain. Through genetic engineering techniques, it should be possible to at least double that yield.

Possibilities also exist for using microbes to produce valuable new products. For example, John E. Kinsella of Cornell University is trying to determine whether microbes could be engineered to produce a cocoa extract from carbohydrates. Perhaps in the future, similar research could yield coffee, tea, and foods that are not now available.

Environmental Risks

While genetic engineering promises great advances for agriculture, it also carries with it environmental risks. Experience with one of the first genetically engineered organisms, the ice-minus bacterium, illustrates the potential environmental effects that must be studied before releasing an engineered organism. Last spring, a sharp controversy arose after Advanced Genetic Sciences, developer of the frost-resistant *Pseudomonas syringae* strain, injected it into trees on the roof of a building before receiving the approval of the Environmental Protection Agency (EPA).

Wild *Pseudomonas syringae* reduces productivity

The *Pseudomonas syringae* bacterium, modified to reduce plants' susceptibility to frost, might eventually be approved for spraying on crops. But there is a slight chance that the organism could lower productivity in some plants such as peach trees.

in many of the crop families on which the ice-minus type may be used. These include the Rose family, which contains a number of fruit trees; the Pea family, which includes nitrogen-fixing clovers; the Grass family, which includes wheat and other major grains; and the Nightshade family, which includes potatoes and tomatoes. Productivity suffers after a frost. But what might happen if the modified *Pseudomonas* lowered plant productivity regardless of frosts? There is a slight chance that this could occur.

Some evidence also suggests that the ice-minus bacterium makes some insects more resistant to freezing, which could hurt crops if the insects are pests. Furthermore, when Advanced Genetic Sciences tested the bacterium outdoors, it did not have enough evidence from laboratory and greenhouse tests to determine how the engineered organism would affect beneficial plants and animals. For example, consider what would happen if it caused disease in honeybees. The honeybee pollinates about $20 billion worth of U.S. crops annually and is a major pollinator of wild plants.

Another furor arose this past year when the U.S. Department of Agriculture (USDA) approved the use of a genetically engineered live-virus swine vaccine without going through its established procedure of consulting its Recombinant DNA Committee. Fortunately, all tests indicate that pseudorabies vaccine is unable to threaten other mammals. But in the future, thorough tests will be needed to certify that altered live-virus vaccines do not have the potential for causing the very diseases they are supposed to prevent, threatening animals and even humans. Such problems have occurred from the use of some polio and rabies vaccines.

Monsanto is now submitting another species of genetically engineered *Pseudomonas* bacteria to extensive laboratory and greenhouse tests. The product is the combination of a *Pseudomonas* organism that lives in the soil and a toxic element from *Baccillus thuringiensis* (*B.t.*). *B.t.*, a bacterium that is sprayed on many crops to control caterpillars, normally cannot live for more than a short time in soil. However, the genetically engineered organism can survive there and might control such major soil insects as the black cutworm, a corn pest that causes $10 million to $50 million in damages each year. But it is critical to ensure that the engineered bacterium cannot also kill earthworms and beneficial soil insects.

Scientists know, largely from laboratory studies, that engineered microorganisms can transfer genes to plants. Therefore, some of the genetic characters added to crop plants could possibly be transferred to weeds. If a gene added to a cereal grain to enable it to resist a plant pathogen were transferred to a weed species of the same family, the weed would resist the pathogen and be able to spread faster. The odds of this happening are extremely small, but such an occurrence could alter the ecosystems of both natural lands and farms.

Clearly, there is always room for another organism in an ecological system. Communities of plants and animals are tremendously flexible in accommodating new genetic variations and species. After all, about 1,500 insect species have been introduced and become established in the United States since 1640. Several of these, like the gypsy moth, have become serious pests.

Some scientists, including Nobel laureate David Baltimore, claim that engineered organisms will likely be weaker than natural organisms in the environment, and will therefore not survive long enough to cause ecological problems. But other biologists such as Steven Lindow, who works at the University of California at Berkeley and has consulted with Advanced Genetic Sciences, claim that modified organisms will survive well in nature because they have been changed only slightly from their natural form. The actual outcome will depend on the particular organism and the specifics of the genetic engineering. The soundest policy is to thoroughly study the ecological interactions of each engineered organism in the lab and greenhouse before releasing it into the environment.

The Problems of Herbicide Resistance

Herbicide-resistant crops are an example of a genetically engineered agricultural product that could have a complicated effect on both the environment and the business of agriculture. If a crop can be developed that is not affected by an herbicide that normally kills a broad range of plants, the chemical can be used to eliminate weeds without damaging the crop. This could enable farmers to grow certain crops in regions that now are troubled by burdensome weeds.

However, weeds that can resist the herbicides would become more numerous. Ever more herbicides would be needed to kill the resistant weeds, creating a treadmill effect. In addition, the problem of herbicides drifting onto adjacent fields planted with non-resistant crops would grow worse as more herbicides were applied. This phenomenon already

Reliance on crops engineered to resist herbicides would increase herbicide use. This could alter some crops' physiology, making them more susceptible to pests. Previous tests have shown that corn treated with the herbicide 2,4-D was infested with three times as many corn-leaf aphids.

destroys more than $70 million worth of crops every year.

Most resistant crop lines are being developed to withstand herbicides with active ingredients that break down rapidly into harmless components, or that cannot leach appreciably into groundwater. However, some crop lines are being developed to resist the more dangerous herbicides. If these were marketed, soil and water pollution would increase, since more of those herbicides would then be used.

Similarly, greater use of persistent herbicides would prevent crop rotations of herbicide-sensitive plants in soil contaminated by the compounds. This could intensify soil erosion and problems with pest populations that thrive on crops that are grown in the same place annually. Even now, some crops cannot be seasonally rotated if certain herbicides are used. For example, soybeans cannot be planted after a corn crop is grown if residues of the herbicide atrazine remain in the soil. For these reasons, I doubt that crop lines that can resist persistent herbicides will be marketed.

But the increased use of any herbicide—whether persistent or not—might make some crops more susceptible to certain diseases and insect pests by altering the plants' physiologies. When corn was treated with the recommended dosages of the popular herbicide 2,4-D, which breaks down within several weeks, it became infested with three times as many corn-leaf aphids. The corn also became much more susceptible to European corn borers, corn smut disease, and Southern corn-leaf blight. Herbicide-resistant crop lines could end up requiring more insecticides and fungicides if more herbicides were used, intensifying environmental problems.

An unanticipated economic side effect of the effort to engineer herbicide-resistant plants has been the move by a few herbicide producers, including Monsanto and CIBA-Geigy Corp., to buy seed companies. The chemical companies' goal is to sell farmers packages of the modified seed and the herbicide. Farmers using the seed would have no choice but to use the companies' corresponding herbicides.

Herbicide-resistant crop lines will probably be popular only in areas that have special weed problems. If the companies that produce the crop lines succeed in selling them widely in those regions, farmers may face problems because genetic diversity will be reduced. A narrow genetic base has caused serious damage to crop yields before. In the early 1970s, American corn farmers relied on varieties that all had one set of genes that, in part, made the crops resistant to the fungus Southern corn-leaf blight. A fungal permutation allowed the blight to cause a loss of about 15 percent of the U.S. corn crop. The loss would have been much smaller if there had been greater genetic diversity. Similarly, the lack of genetic diversity in some rice planted in the Philippines, Thailand, and India has led to a cycle of pest outbreaks, increased pesticide use and pest resistance, and more pollution of farmers' fields.

Social and Economic Liabilities

In addition to creating environmental risks, genetic engineering of agricultural products will create economic and social problems. For example, genetically modified organisms that control pests and diseases will increase food supplies and therefore reduce prices in the marketplace, speeding the demise of small farms.

Consider the mixed blessings associated with bovine growth hormone (BGH), which increases milk production in cattle as much as 30 percent and can be produced using genetically engineered organisms. The USDA and the Food and Drug Administration (FDA) are expected to approve the hormone for general use in about a year. Because farmers will need fewer cows and therefore perhaps 10 percent less food to produce the same amount of milk, their production costs and the amount of land needed for forage crops will drop. But this advance comes at a time when milk production is at an all-time high and diet-conscious Americans are consuming less. The USDA is already paying some farmers to eliminate their herds of dairy cattle. Other nations that can afford to buy more dairy products also have a surplus, so there is little likelihood that the market can absorb even more milk products.

This means that the use of BGH will reduce the number of dairy farms even further, continuing the trend of the past two decades. This outcome will entail both financial disaster and great emotional cost to those whose farms fail, and will exacerbate the already severe problems of communities, banks, and state treasuries in farming regions.

By helping to eliminate small farmers, genetic engineering will speed the increase in the size and industrialization of farms that is already occurring throughout the world. From 1954 to 1985 the number of U.S. farms dropped by more than half, from 4.8 million to 2.3 million. At the same time the average farm size almost doubled, from 242 acres to about 445 acres. The loss of small American farmers

is unfortunate, since they contribute to the social diversity of an increasingly urban society.

Ensuring the Success of Engineered Crops

There are a number of ways to address the problems that the engineering of agricultural products could entail. For example, scientists working in temperate zones should engineer only tropical organisms, which would die out during the cold weather. U.S. growers must already contend with several thousand pest species; we do not need genetic engineering to add more to this list. U.S. manufacturers might want to sell some of their engineered products in the tropics, but that should be allowed only if thorough analysis indicates that this would not create environmental problems.

Setting up regulatory procedures is a much-needed first step in controlling such activities. In June 1986, the federal government approved rules and guidelines for regulating the biotechnology industry. Responsibility for weighing the safety of new products was divided among five federal agencies:

☐ The USDA is responsible for engineered organisms used with crop plants and animals.

☐ The FDA is responsible for genetically engineered organisms in foods and drugs.

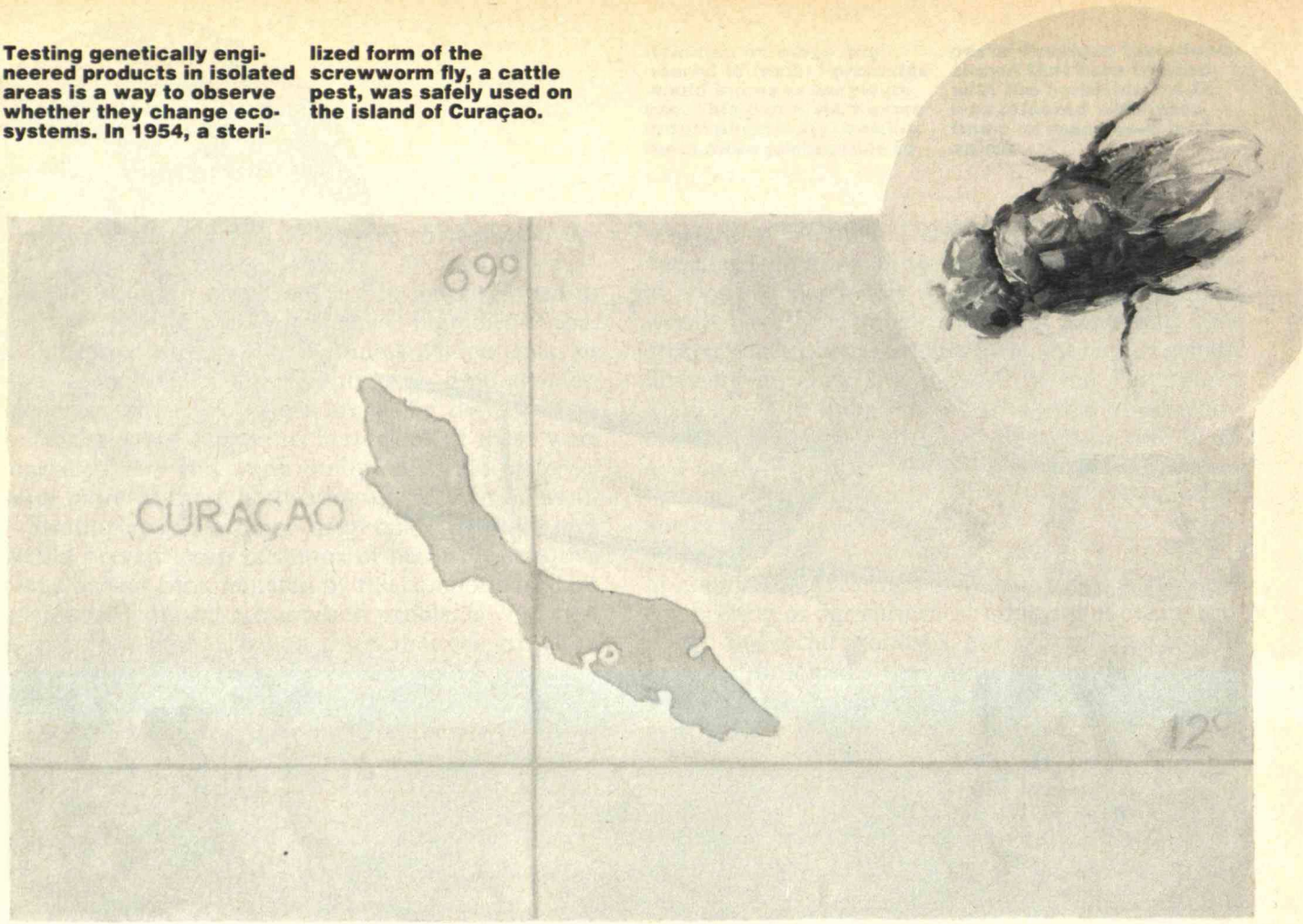
☐ The National Institutes of Health are responsible for engineered organisms that could affect public health.

☐ The Occupational Safety and Health Administration (OSHA) is responsible for engineered organisms that may affect the workplace.

☐ The EPA is responsible for engineered organisms released into the environment for pest and pollution control and related activities.

However, many scientists believe that these divisions of authority are cumbersome and inadequate. Agencies such as the USDA both promote and regulate the new technology. That combination did not work when the USDA was responsible for the use of pesticides, so control of those substances was transferred to the EPA in 1970. In my opinion, biotechnology should be regulated primarily by the EPA and OSHA—agencies that are set up to regulate rather than promote industries. The other agencies could contribute representatives to the EPA and OSHA committees that would review the release of engineered organisms.

These agencies should ensure that sound ecological protocols are followed before any genetically engineered organism is released into the environment. Although there is only a small chance that such an organism could cause an environmental



Testing genetically engineered products in isolated areas is a way to observe whether they change ecosystems. In 1954, a sterilized form of the screwworm fly, a cattle pest, was safely used on the island of Curaçao.

problem, a single mistake could led to a major disaster. To reduce risks, the government should require companies to thoroughly test engineered plants and organisms in the laboratory and the greenhouse to determine their potential for surviving and reproducing in nature. Such efforts would require teams of microbiologists, ecologists, plant breeders, agronomists, wildlife specialists, public-health specialists, and botanists to work together.

As part of this process, the developer of an engineered product should have to identify every potential plant and animal that an engineered organism could attack and the possible interactions. For example, the ice-minus bacterium should be tested on all major crops in which it could lower productivity. It should also be exposed to several important species of wild plants and beneficial insects to determine its effects. (Advanced Genetic Sciences has taken most of these steps.) And geneticists should document the potential of an engineered organism for transferring genetic material to other species.

After conducting indoor tests, the developer of a modified product should conduct field tests on islands and similarly isolated areas. This has been done before with the screwworm fly, which in its maggot stage infests cattle and other mammals. In 1954 sterilized screwworm flies (not genetically engineered) were dropped on the island of Curaçao to see whether they could control infestation.

It is also essential that government take into account the economic and social impacts of genetic engineering when deciding whether to approve these products. For example, if some farmers and farm laborers who are forced out of agriculture because of bovine growth hormone turn to welfare, any benefits associated with lower food costs could be eliminated by increased taxes to support welfare. On the other hand, economic problems would be minimized if displaced farmers were assisted in finding other gainful employment. Unfortunately, other jobs may not be available or may be low-paying service positions. Given the current lack of social policies to aid steel and textile workers whose jobs have been eliminated by automation, the odds are that another poor, disillusioned sector of American society will develop.

Granted, it is costly and time-consuming to protect society and the environment from possible problems related to genetic engineering. But that could ensure the success of the industry. Surely we have learned from our past mistakes with pesticides that it takes many years to regain public confidence in the safety of new technologies once that assurance has been lost. □

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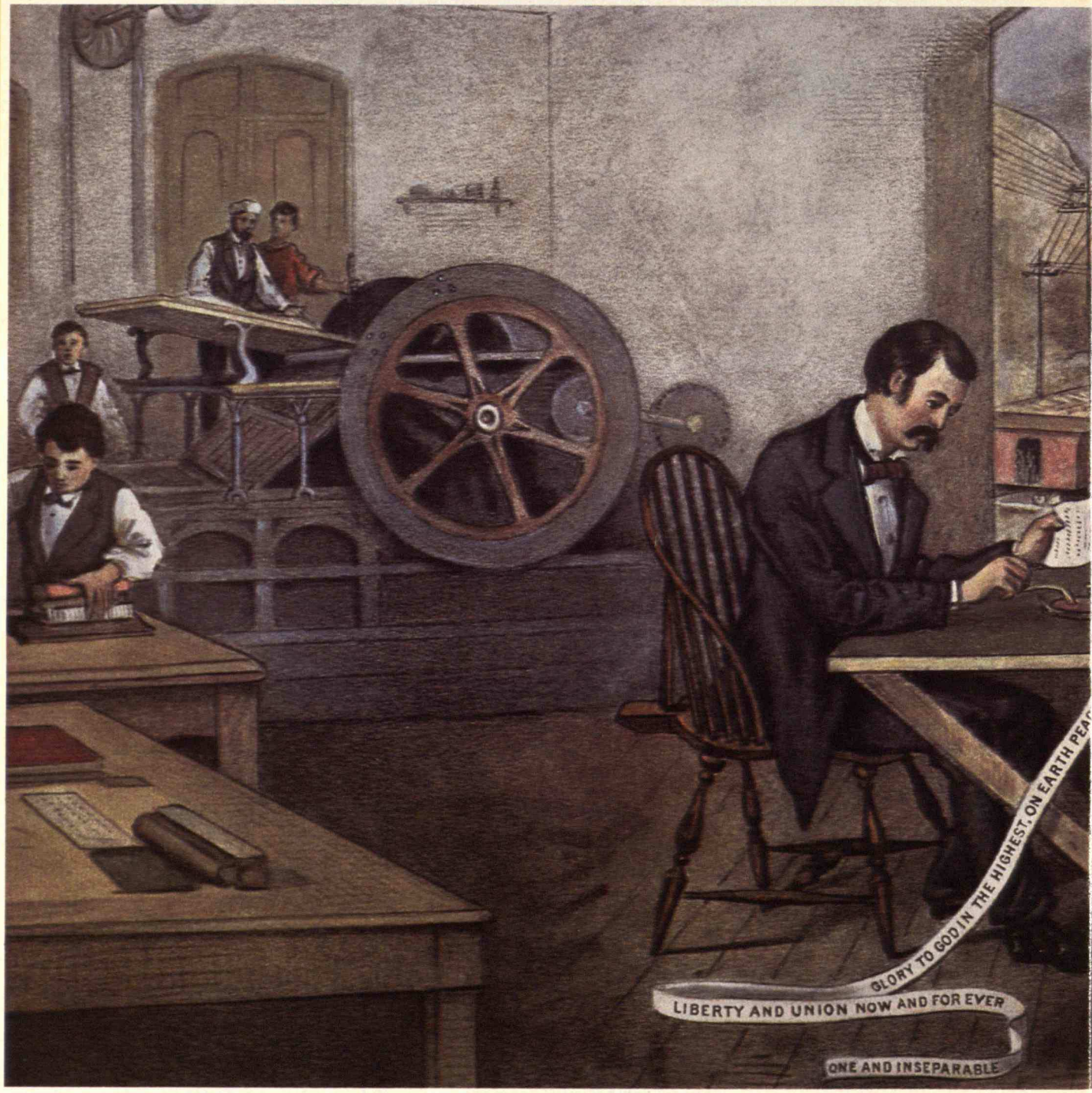
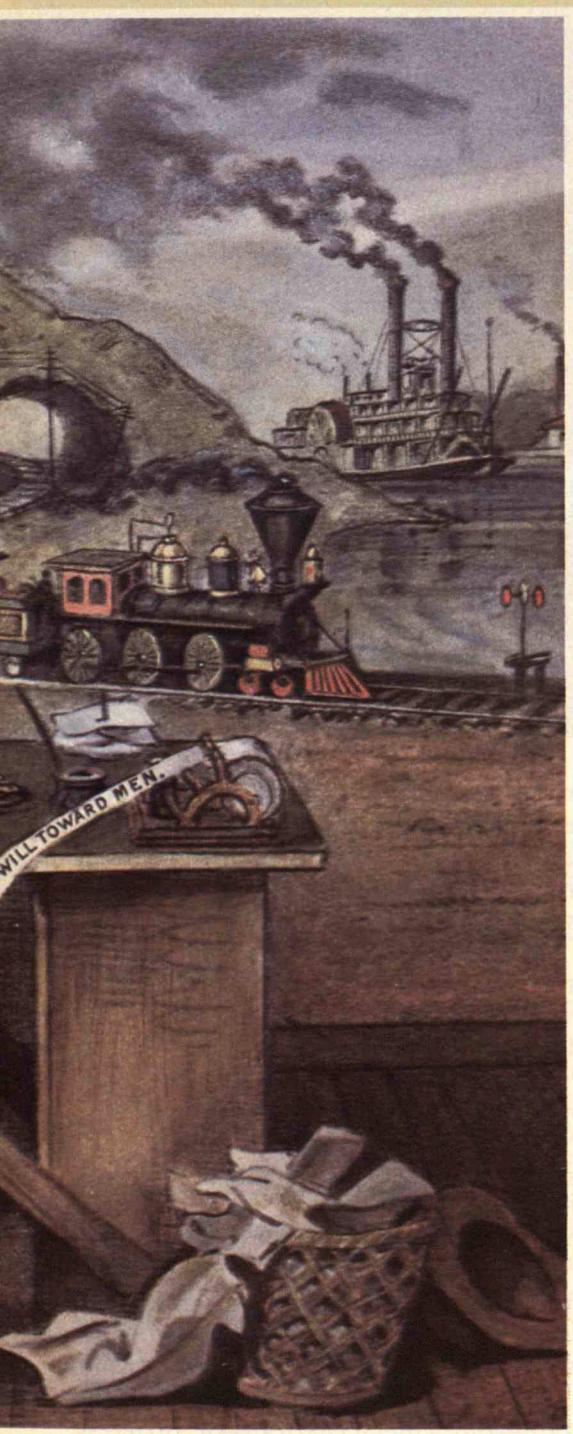


"Progress of the Century," 1876



Does Improved Technology Mean Progress?

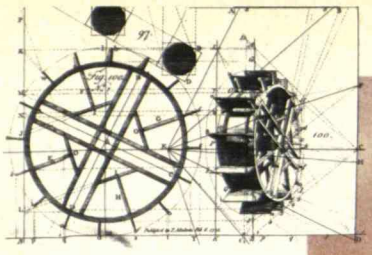
Understanding the historical distinction between two contradictory concepts of progress helps explain the current disenchantment with technology.

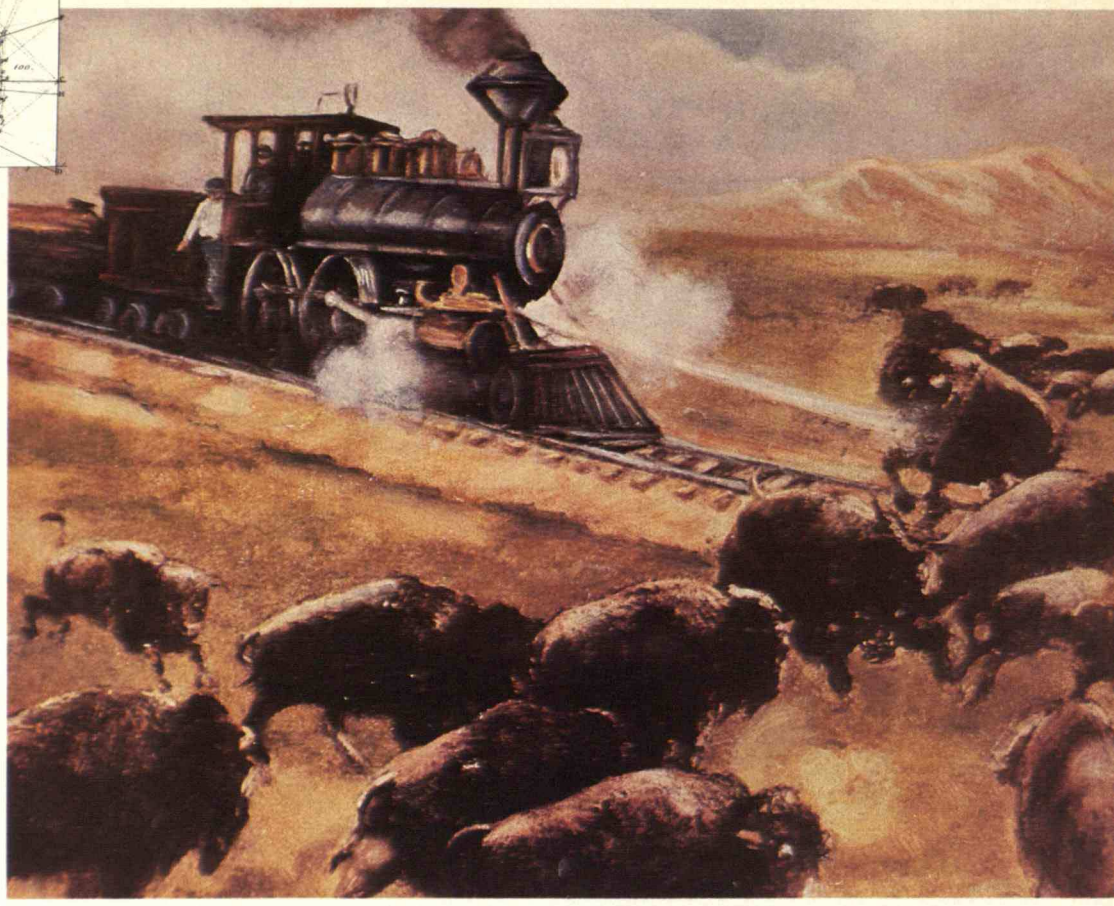
BY LEO MARX

DOES improved technology mean progress? If some variant of this question had been addressed to a reliable sample of Americans at any time since the early nineteenth century, the answer of a majority almost certainly would have been an unequivocal "yes." The idea that technological improvements are a primary basis for—and an accurate gauge of—progress has long been a fundamental belief in the United States. In the last half-century, however, that belief has lost some of its credibility. A growing minority of Americans has adopted a skeptical, even negative, view of technological innovation as an index of social progress.

The extent of this change in American attitudes was brought home to me when I spent October 1984 in China. At that time the announced goal of the People's Republic was to carry out (in the popular slogan) "Four Modernizations"—agriculture, science and technology, industry, and the military. What particularly struck our group of Americans was the seemingly unbounded, largely uncritical ardor with which the Chinese were conducting their love affair with Western-style modernization—individualistic, entrepreneurial, or "capitalist," as well as scientific and technological. Like early nineteenth-century visitors to the United States, we were wit-

ALL ILLUSTRATIONS: THE BETTMAN ARCHIVE





In the late eighteenth century, Enlightenment philosphers regarded science and technology not as ends in themselves but as instruments for transforming society. They expected scientific knowledge and technological power to make possible a comprehensive improvement in all the conditions of life.

nessing a society in a veritable transport of improvement: long pent-up, innovative energies were being released, everyone seemed to be in motion, everything was eligible for change. It was assumed that any such change almost certainly would be for the better.

Most of the Chinese we came to know best—teachers and students of American studies—explicitly associated the kind of progress represented by the four modernizations with the United States. This respect for American wealth and power was flattering but disconcerting, for we often found ourselves reminding the Chinese of serious shortcomings, even some terrible dangers, inherent in the Western mode of industrial development. Like the Americans whom European travelers met 150 years ago, many of the Chinese seemed to be extravagantly, almost blindly, credulous and optimistic.

Our reaction revealed, among other things, a change in our own culture and, in some cases, in our own personal attitudes. We came face to face with the gulf that separates the outlook of many contemporary Americans from the old national faith in the advance of technology as the basis of social progress.

The standard explanation for this change includes that familiar litany of death and destruction that distinguishes the recent history of the West: two barbaric world wars, the Nazi holocaust, the Stalinist terror, and the nuclear arms race. It is striking to note how many of the fearful events of our time involve the destructive use or misuse, the unforeseen consequences, or the disastrous malfunction of modern technologies: Hiroshima and the nuclear threat; the damage inflicted upon the environment by advanced industrial societies; and spectacular accidents like Three Mile Island.

Conspicuous disasters have helped to undermine the public's faith in progress, but there also has been a longer-term change in our thinking. It is less obvious, less dramatic and tangible than the record of catastrophe that distinguishes our twentieth-century history, but I believe it is more fundamental. Our very conception—our chief criterion—of progress has undergone a subtle but decisive change since the founding of the Republic, and that change is at once a cause and a reflection of our current disenchantment with technology. To chart this change in attitude, we need to go back at least as far as the first Industrial Revolution.

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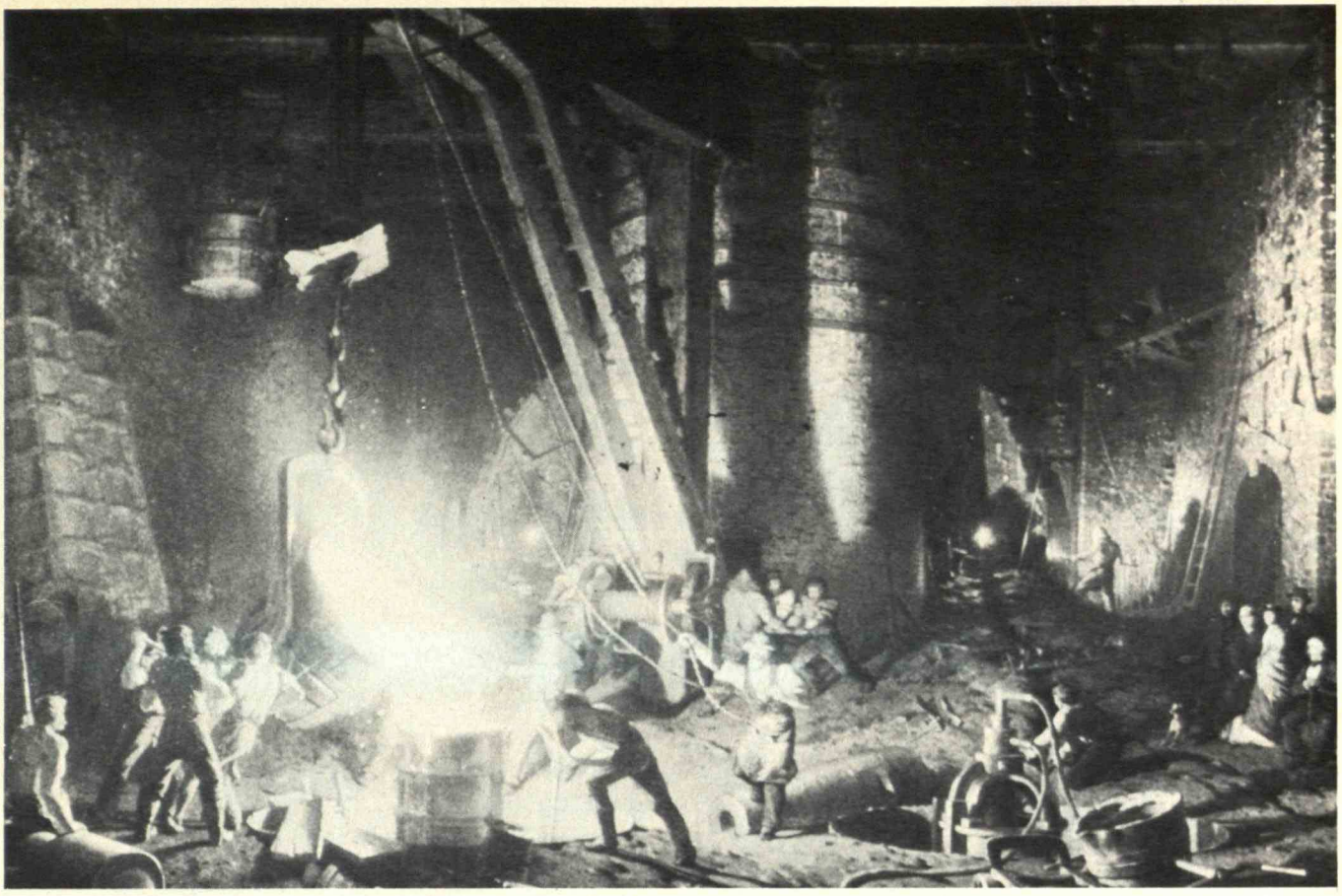


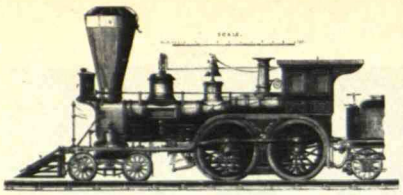
The Enlightenment Belief in Progress

The development of radically improved machinery (based on mechanized motive power) used in the new factory system of the late eighteenth century coincided with the formulation and diffusion of the modern Enlightenment idea of history as a record of progress. This conception became the fulcrum of the dominant American worldview. It assumes that history, or at least modern history, is driven by the steady, cumulative, and inevitable expansion of human knowledge of and power over nature. The new scientific knowledge and technological power was expected to make possible a comprehensive improvement in all the conditions of life—social, political, moral, and intellectual as well as material.

The modern idea of progress, as developed by its radical French, English, and American adherents, emerged in an era of political revolution. It was a revolutionary doctrine, bonded to the radical struggle for freedom from feudal forms of domination. To ardent republicans like the French philospher Condorcet, the English chemist Priestley, and Benjamin Franklin, a necessary criterion of progress was the achievement of political and social liberation. They regarded the new sciences and technologies not as ends in themselves, but as instruments for carrying out a comprehensive transformation of society. The new knowledge and power would provide the basis for alternatives to the deeply entrenched authoritarian, hierarchical institutions of *l'ancien régime*: monarchical, aristocratic, and ecclesiastical. Thus in 1813 Thomas Jefferson wrote to John Adams describing the combined effect of the new science and the American revolution on the minds of Europeans:

Science had liberated the ideas of those who read and reflect, and the American example had kindled feelings of right in the people. An insurrection has consequently begun, of science, talents, and courage, against rank and birth, which have

Although Thomas Jefferson was a committed believer in the benefits of science and technology, he rejected the idea of developing an American factory system. He thought that industrial cities and an industrial working class were incompatible with republican government and the happiness of the people.



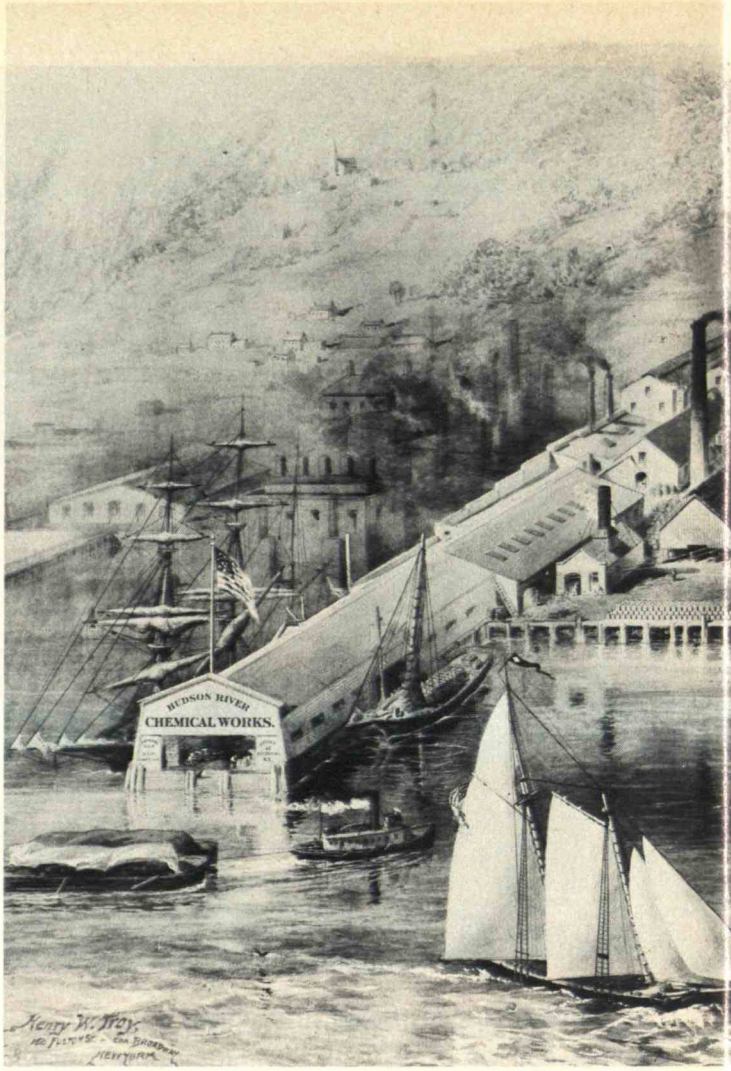
fallen into contempt. . . . Science is progressive.

Admittedly, the idea of history as endless progress did encourage extravagantly optimistic expectations, and in its most extreme form, it fostered some wildly improbable dreams of the "perfectability of Man" and of humanity's absolute mastery of nature. Yet the political beliefs of the radical republicans of the eighteenth century, such as the principle of making the authority of government dependent upon the consent of the governed, often had the effect of limiting those aspirations to omnipotence.

Like Jefferson, Benjamin Franklin exemplified how republican political ideals constrained the use of technology. He refused to exploit his inventions for private profit, considering them to be for the benefit of all.

The constraining effect of such ultimate, long-term political goals makes itself felt, for example, in Jefferson's initial reaction to the prospect of introducing the new manufacturing system to America. "Let our work-shops remain in Europe," he wrote in 1785.

Although a committed believer in the benefits of science and technology, Jefferson rejected the idea of developing an American factory system on the ground that the emergence of an urban proletariat, which he then regarded as an inescapable consequence of the European factory system, would be too high a price to pay for any potential improvement in the American material standard of living. He regarded the existence of manufacturing cities and an industrial working class as incompatible with republican government and the happiness of the people. He argued that it was preferable, even if more costly in strictly economic terms, to ship raw materials to Europe and import manufactured goods. "The loss by the transportation of commodities across the Atlantic will be made up in happiness and permanence of government." In weighing political, moral, and aesthetic costs against economic benefits, he anticipated the viewpoint of the environmentalists

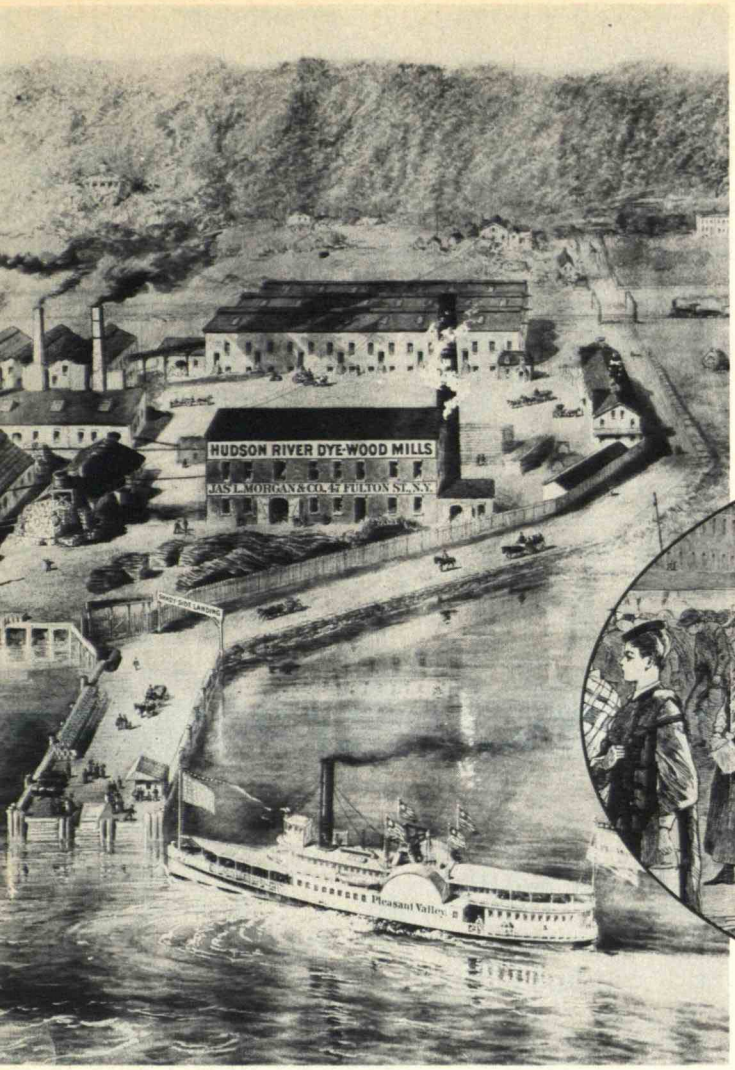


and others of our time for whom the test of a technological innovation is its effect on the overall quality of life.

Another instance of the constraining effect of republican political ideals is Benjamin Franklin's refusal to exploit his inventions for private profit. Thus Franklin's reaction when the governor of Pennsylvania urged him to accept a patent for his successful design of the "Franklin stove:"

Governor Thomas was so pleased with the construction of this stove as described in . . . [the pamphlet] that . . . he offered to give me a patent for the sole vending of them for a term of years; but I declined it from a principle which has ever weighed with me on such occasions, namely; viz., that as we enjoy great advantages from the inventions of others, we should be glad of an opportunity to serve others by any invention of ours, and this we should do freely and generously [emphasis in original].

What makes the example of Franklin particularly interesting is the fact that he later came to be regarded as the archetypal self-made American and the embodiment of the Protestant work ethic. When Max Weber sought out of all the world *the* exemplar



Left: This representation of Hudson River factories reflects a positive view of technology. Below: Winslow Homer's characterization of New England factory workers is more critical.

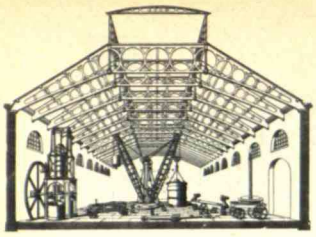
of that mentality for his seminal study, *The Protestant Ethic and the Spirit of Capitalism,* whom did he choose but our own Ben? But Franklin's was a principled and limited self-interest. In his *Autobiography,* he told the story of his rise in the world not to exemplify a merely personal success, but rather to illustrate the achievements of a "rising people." He belonged to that heroic revolutionary phase in the history of the bourgeoisie when that class saw itself as the vanguard of humanity and its principles as universal. He thought of his inventions as designed not for his private benefit but for the benefit of all.

The Technocratic Concept of Progress

With the further development of industrial capitalism, a quite different conception of technological progress gradually came to the fore in the United States. Americans celebrated the advance of science and technology with increasing fervor, but they began to detach the idea from the goal of social and political liberation. Many regarded the eventual attainment of that goal as having been assured by the victorious American Revolution and the founding of the Republic.

The difference between this later view of progress and that of Jefferson's and Franklin's generation can be heard in the rhetoric of Daniel Webster. He and Edward Everett were perhaps the leading public communicators of this new version of the progressive ideology. When Webster decided to become a senator from Massachusetts instead of New Hampshire, the change was widely interpreted to mean that he had become the quasi-official spokesman for the new industrial manufacturing interests. Thus Webster, who was generally considered the nation's foremost orator, was an obvious choice as the speaker at the dedication of new railroads. Here is a characteristic peroration of one such performance in 1847:

It is an extraordinary era in which we live. It is altogether new. The world has seen nothing like it before. I will not pretend, no one can pretend, to discern the end; but everybody knows that the age is remarkable for scientific research into the heavens, the earth, and what is beneath the earth; and perhaps more remarkable still for the application of this scientific research to the pursuits of life. . . . We see the



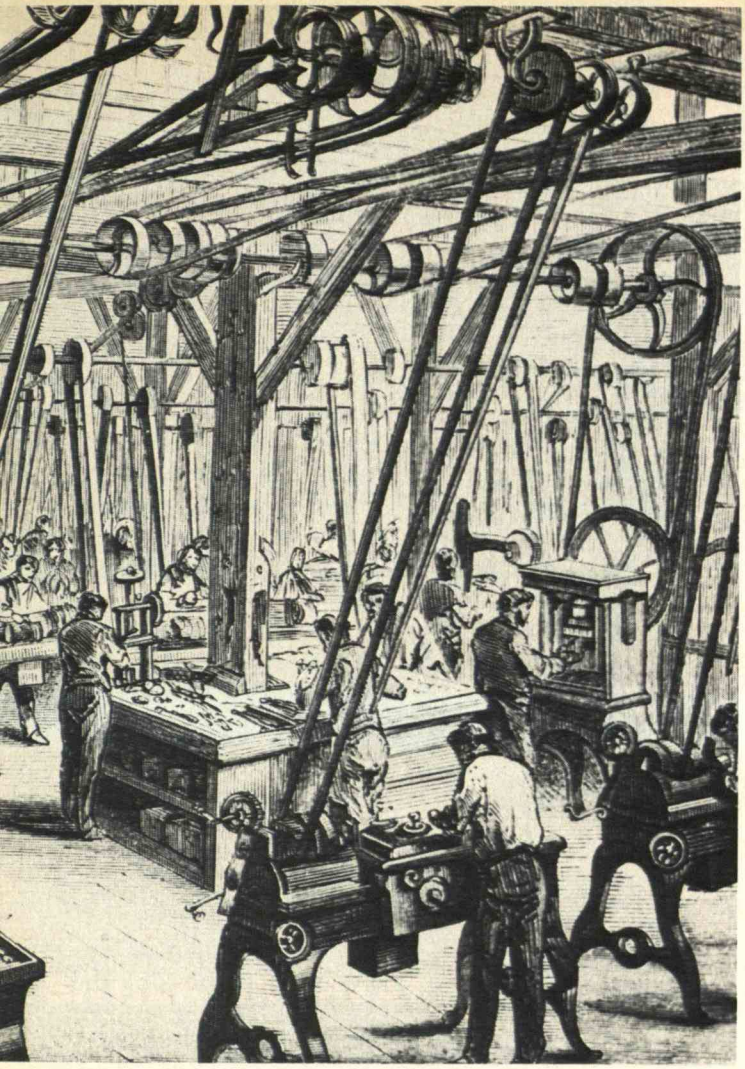
ocean navigated and the solid land traversed by steam power, and intelligence communicated by electricity. Truly this is almost a miraculous era. What is before us no one can say, what is upon us no one can hardly realize. The progress of the age has almost outstripped human belief; the future is known only to Omniscience.

By the 1840s, as Webster's rhetoric suggests, the the idea of progress was already being dissociated from the Enlightenment vision of political liberation. He invests the railroad with a quasi-religious inevitability that lends force to the characterization of his language as the rhetoric of the technological sublime. Elsewhere in the speech, to be sure, Webster makes the obligatory bow to the democratic influence of technological change, but it is clear that he is casting the new machine power as the prime exemplar of the overall progress of the age, quite apart from its political significance. Speaking for the business and industrial elite, Webster and Everett thus depict technological innovation as a sufficient cause, *in itself,* for the fact that history assumes the character of continuous, cumulative progress.

At the same time, discarding the radical political ideals of the Enlightenment allowed the idea of technological progress to blend with other grandiose national aspirations. Webster's version of the "rhetoric of the technological sublime" is of a piece with the soaring imperial ambitions embodied in the slogan "Manifest Destiny," and by such tacit military figurations of American development as the popular notion of the "conquest of nature" (including Native Americans) by the increasingly technologized forces of advancing European-American "civilization." These future-oriented themes easily harmonized with the belief in the coming of the millenium that characterized evangelical Protestantism, the most popular American religion at the time. Webster indicates as much when, at the end of his tribute to the new railroad, he glibly brings in "Omniscience" as the ultimate locus of the meaning of progress.

Daniel Webster cast machine power as the exemplar of progress, disregarding its political uses.

The difference between the earlier Enlightenment conception of progress and that exemplified by Webster is largely attributable to the difference between the groups they represented. Franklin, Jefferson, and the heroic generation of founding revolutionists constituted a distinct, rather unusual social class in that for a short time the same men possessed authority and power in most of its important forms: economic, social, political, and intellectual. The industrial capitalists for whom Daniel Webster spoke were men of a very different stripe. They derived their status from a different kind of wealth and power, and their conception of progress, like their economic and social aspirations, was correspondingly different. The new technology and the immense profits it generated belonged to them, and since they had every reason to assume that they would retain their property and power, they had a vested interest in technological innovation. It is not surprising, under the circumstances, that as indus-



Most Americans welcomed the factory of the nineteenth century, which is shown in this 1865 woodcut. But critics such as Hawthorne, Thoreau, and Melville prefigured environmentalists of the twentieth century.

trialization proceeded these men became true believers in technological improvement as the primary basis for—as virtually tantamount to—universal progress.

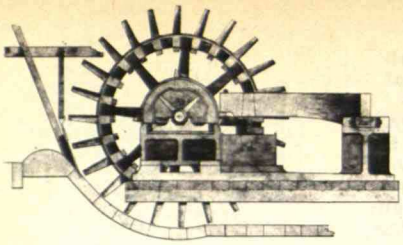
This dissociation of technological and material advancement from the larger political vision of progress was an intermediate stage in the eventual impoverishment of that radical eighteenth-century worldview. This subtle change prepared the way for the emergence, later in the century, of a thoroughly technocratic idea of progress. It was "technocratic" in that it valued improvements in power, efficiency, rationality as ends in themselves. Among those who bore witness to the widespread diffusion of this concept at the turn of the century were Henry Adams and Thorstein Veblen, who were critical of it, and Andrew Carnegie, Thomas Edison, and Frederick Winslow Taylor and his followers, who lent expression to it. Taylor's theory of scientific management embodies the quintessence of the technocratic mentality, "the idea," as historian Hugh Aitken describes it, "that human activity could be measured, analyzed, and controlled by techniques analogous to those that had proved so successful when applied to physical objects."

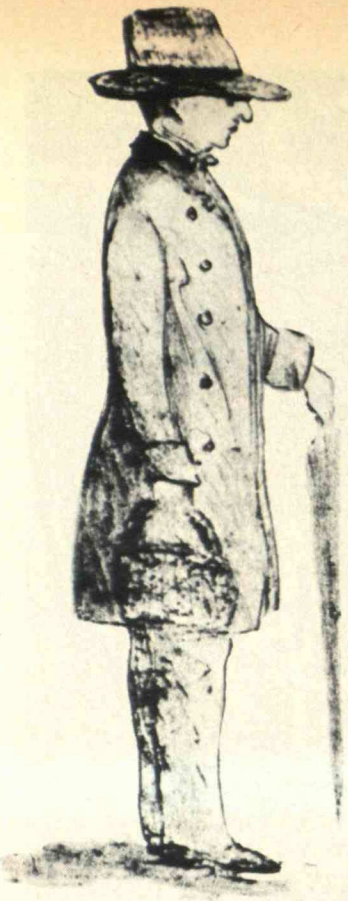
The technocratic idea of progress is a belief in the sufficiency of scientific and technological innovation as the basis for general progress. It says that if we can ensure the advance of science-based technologies, the rest will take care if itself. (The "rest" refers to nothing less than a corresponding degree of improvement in the social, political, and cultural conditions of life.) Turning the Jeffersonian ideal on its head, this view makes instrumental values fundamental to social progress, and relegates what formerly were considered primary, goal-setting values (justice, freedom, harmony, beauty, or self-fulfillment) to a secondary status.

In this century, the technocratic view of progress was enshrined in Fordism and an obsessive interest in economies of scale, standardization of process and product, and control of the workplace. This shift to mass production was accompanied by the more or less official commitment of the U.S. government to the growth of the nation's wealth, productivity, and global power, and to the most rapid possible rate of technological innovation as the essential criterion of social progress.

Along with Webster, Edward Everett espoused the view that technology is progressive in and of itself.

But the old republican vision of progress—the vision of advancing knowledge empowering humankind to establish a less hierarchical, more just and peaceful society—did not disappear. If it no longer inspired Webster and his associates, it lived on in the minds of many farmers, artisans, factory workers, shopkeepers, and small-business owners, as well as in the beliefs of the professionals, artists, intellectuals, and other members of the lower middle and middle classes. During the late nineteenth century, a number of disaffected intellectuals sought new forms for the old progressive faith. They translated it into such political idioms as utopian socialism, the single-tax movement, the populist revolt, Progressivism in cities, and Marxism and its native variants.





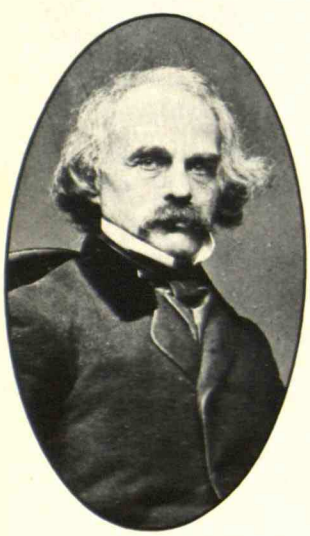
Henry Thoreau's *Walden* may be read as an attack on a culture confused about the relationship between ends and means.

The Roots of Our Adversary Culture

Let me turn to a set of these late-eighteenth-century ideas that was to become the basis for a powerful critique of the culture of advanced industrial society. Usually described as the viewpoint of the "counter-Enlightenment" or the "romantic reaction," these ideas have formed the basis for a surprisingly long-lived adversarial culture.

According to conventional wisdom, this critical view originated in the intellectual backlash from the triumph of the natural sciences we associate with the great discoveries of Galileo, Kepler, Harvey, and Newton. Put differently, this tendency was a reaction against the extravagant claims for the universal, not to say exclusive, truth of "the Mechanical Philosophy." That term derived from the ubiquity of the machine metaphor in the work of Newton and other natural scientists ("celestial mechanics") and many of their philosophic allies, notably Descartes, all of whom tended to conceive of nature itself as a "great engine" and its subordinate parts (including the human body) as lesser machines.

By the late eighteenth century, a powerful set of critical, anti-mechanistic ideas was being developed by Kant, Fichte, and other German idealists, and by great English poets like Coleridge and Wordsworth. But in their time the image of the machine also was being invested with greater tangibility and social import. The Industrial Revolution was gaining momentum, and as power machinery was more widely diffused in Great Britain, Western Europe, and North America, the machine acquired much greater resonance: it came to represent both the new technologies based on mechanized motive power and the mechanistic mindset of scientific rationalism. Thus the Scottish philosopher and historian Thomas Carlyle, who had been deeply influenced by the new German philosophy, announced in his seminal 1829 essay, "Signs of the Times," that the right name for the dawning era was the "Age of Machinery." It was to be the Age of Machinery, he warned, in every "inward" and "outward" sense of the word, meaning that it would be dominated by mechanical (utilitarian) thinking as well as by actual machines.



In a satire of *Pilgrim's Progress*, Nathaniel Hawthorne likened a journey on a railroad, the symbol of technology, to a trip to hell.

In his criticism of this new era, Carlyle took the view that neither kind of "machinery" was inherently dangerous. In his opinion, indeed, they represented *potential* progress as long as neither was allowed to become the exclusive or predominant mode in its respective realm.

In the United States a small, gifted, if disaffected minority of writers, artists, and intellectuals adopted this ideology. Their version of Carlyle's critical viewpoint was labeled "romantic" in reference to its European strains, or "transcendentalist" in its native use. In the work of writers like Emerson and Thoreau, Hawthorne and Melville, we encounter critical responses to the onset of industrialism that cannot be written off as mere nostalgia or primitivism. These writers did not hold up an idealized wilderness, a pre-industrial Eden, as preferable to the world they saw in the making. Nor did they dismiss the worth of material improvement as such. But they did regard the dominant view, often represented (as in Webster's speech) by the appearance of the new machine power in the American landscape, as dangerously shallow, materialistic, and one-sided. Fear of "mechanism," in the several senses of that word—especially the domination of the individual by impersonal systems—colored all of their thought. In their work, the image of the machine-in-the-landscape, far from being an occasion for exultation,

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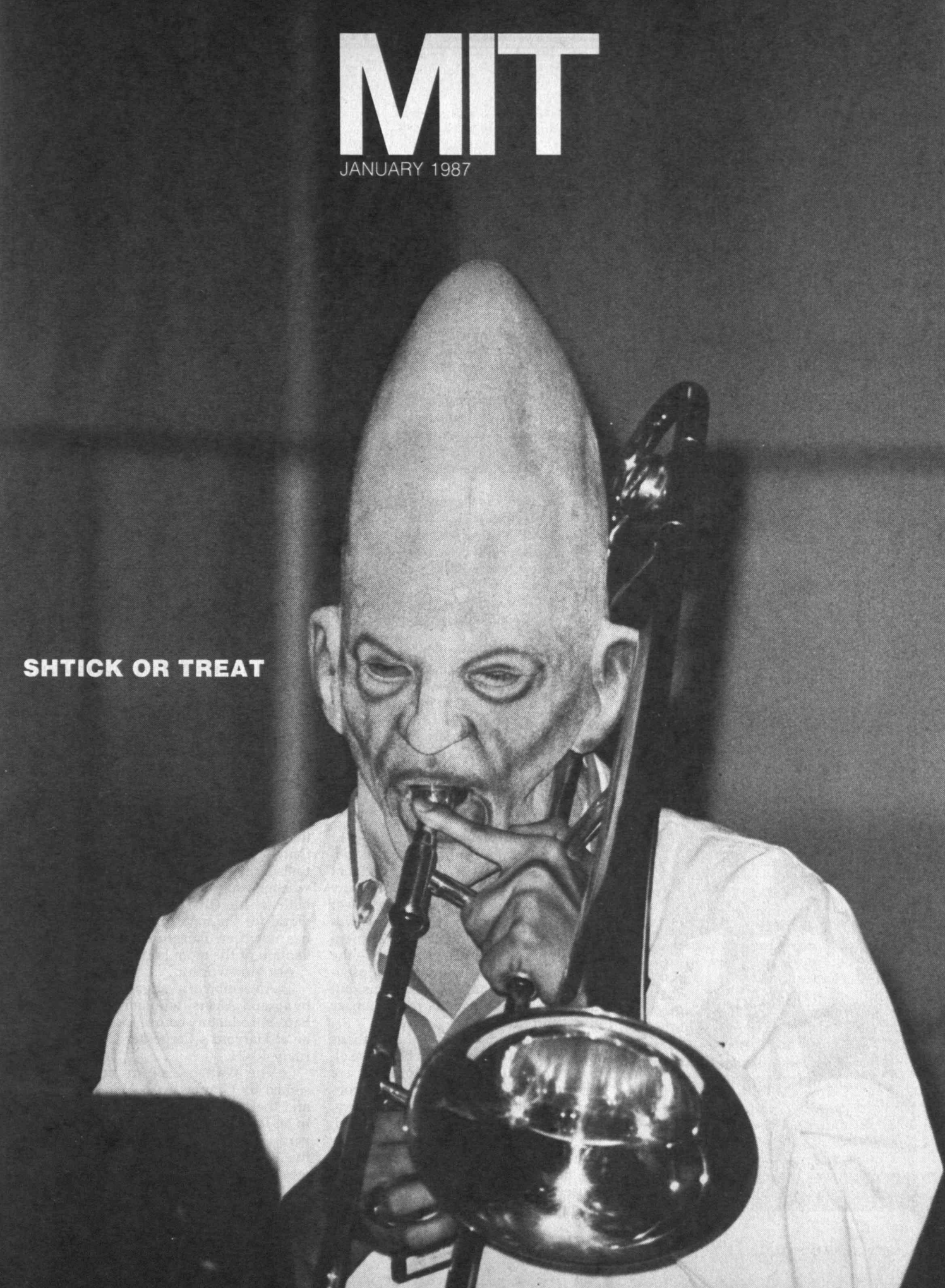

SHTICK OR TREAT

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ABOUT THE COVER
When the M.I.T. Concert Band put on its traditional Hallowe'en performance in Lobby 7, trombonist Paul Salinas, '86, really got into the spirit of the occasion. (Photo by L. Barry Hetherington).

Bauhaus Boston: *The* Cultural Event of the Season

The M.I.T. Museum is at the center of an intense and exhilarating round of exhibits, films, lectures, and special activities in the Boston area focused on the Bauhaus school of art and design.

The Bauhaus operated in Germany between the world wars, but it had lasting effect on the way we all conceive of buildings, art, industrial design, textiles, theater, and countless other aspects of the human-made environment.

The travelling Bauhaus exhibit that came to the M.I.T. Museum was originally assembled by the West German government, but it was supplemented with additional materials from the Boston Area.

Nearly every medium of arts information in the Boston area has covered the M.I.T. exhibit and other Bauhaus Boston events. To give alumni the flavor of the occasion, Technology Review *reprints an article by Robert Campbell and commissioned a companion piece by art critic Tom Frick.*

This exhibit has already broken all attendance records at the M.I.T. Museum, and alumni might well consider swelling those numbers still further.—Ed.

The Enduring Fascination of Bauhaus Design

The world would be very different today if the Bauhaus, a small, obscure school of design, had not flourished for 14 brief years in Germany after World War I. Even if we've never heard of it, we know its works. It was the place where the modern movement in art and architecture was born—the modern movement with its often pseudoscientific, antihuman obsessions, but also with its tremendous revolutionary gusto and excitement.

Something you could call a Bauhaus festival began in October in Boston. Colleges, museums, and libraries are mounting Bauhaus shows, talks, concerts, and films. There's no anniversary, no particular occasion being celebrated; the festival began when some architecture students at M.I.T. helped persuade the newly enlarged, handsome M.I.T. Museum to accept a major travelling exhibition on the Bauhaus. Then Anneliese Harding, director of the Goethe Institute in Boston, persuaded a number of institutions to sponsor concurrent Bauhaus events.

The Bauhaus seems to exert a permanent fascination on our culture. Partly the fascination is with the miracle that so small, so improbable an institution could have reshaped the civilized world. Partly it's a matter of all the eventually world-famous people who taught there—architects Walter Gropius (founder of the Bauhaus) and Mies van der Rohe, painters Paul Klee and Vasily Kandinsky, and many more. And partly, too, no doubt, the Bauhaus' continuing fame is simply the result of the intense propaganda waged on its behalf over the decades by its many true believers.

There's a disturbing side to the Bauhaus, and to much of modernism. People in Bauhaus paintings and plays, for instance, always seem to look like robots. The school at times promulgated something very close to worship of the machine, of abstraction, of what was thought to be (but really wasn't) the scientific method.

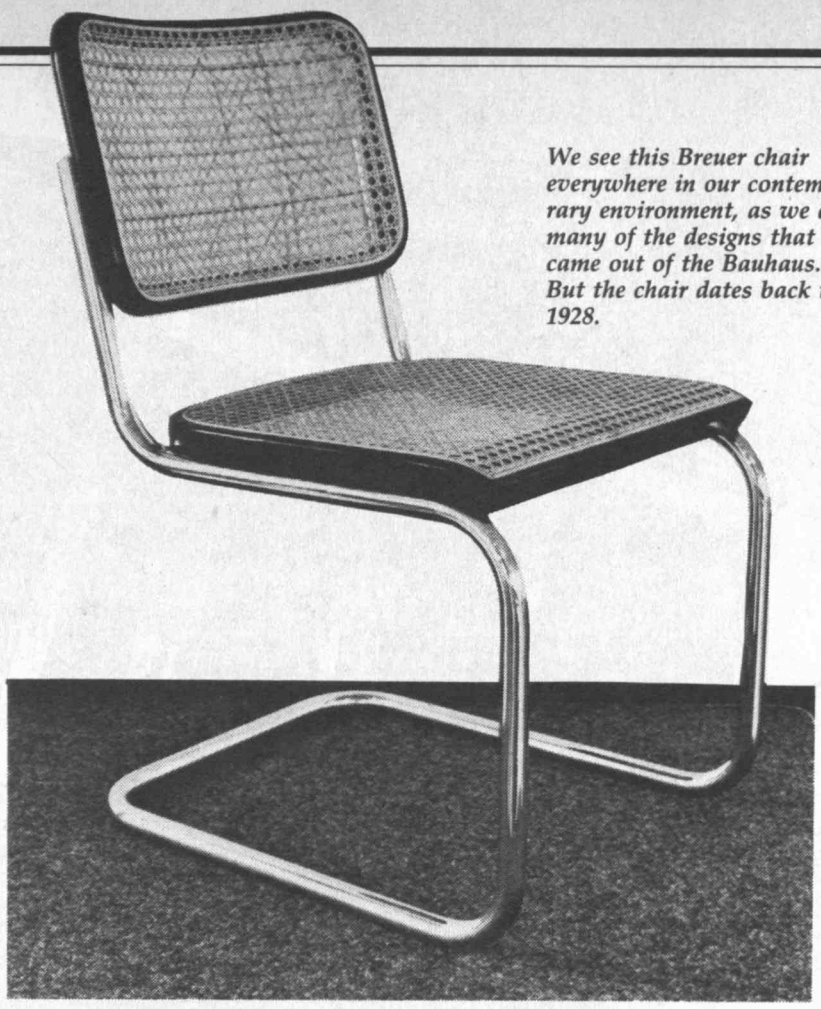
But there was also much talent and courage. People at the Bauhaus believed they were inventing the future. More than anything else, it's that cosmic optimism characteristic of the era that overwhelms us today. Such optimism, such faith in human ability to change the world for the better, is something that has not been recaptured since the invention of the atom bomb.

Also noteworthy:

☐ An exhibit of a series of lithographs by Joseph Albers (who taught the Bauhaus introductory course for a time) will be at Harvard's Carpenter Center February 10–24.

☐ The Walter Gropius house, designed by Gropius with Marcel Breuer and the home of the Bauhaus founder in his later years when he taught at Harvard and led the Architects Collaborative, will be open in Lincoln, Mass. for weekend tours.

☐ An exhibit of books about the Bauhaus is at the Boston Public Library, and



We see this Breuer chair everywhere in our contemporary environment, as we do many of the designs that came out of the Bauhaus. But the chair dates back to 1928.

PHOTO: L. BARRY HETHERINGTON

a show of Bauhaus photography is at the Busch-Reisinger Museum at Harvard.

□ Other Bauhaus events, with times, dates, and addresses, are available from the Goethe Institute, 262-6050.—*Robert Campbell* □

Bauhaus at M.I.T.

The Bauhaus Exhibit at the M.I.T. Museum through the end of February is a large, well-chosen display documenting the widely ranging activities of the teachers and students of this extraordinary German school. Texts, photos, drawings, objects, and slide and video presentations represent the work of such people as Walter Gropius, Mies van der Rohe, Vasily Kandinsky, Laszlo and Sybil Moholy-Nagy, Lyonel Feininger, Paul Klee, Oskar Schlemmer, Herbert Bayer, Marcel Breuer, Johannes Itten, and Anni and Josef Albers. The school brought together an amazing collection of pioneering artists and designers, each remembered more as an individual than as a member of a group. And their influence on the contemporary environment has been so pervasive that the M.I.T. exhibit may seem astonishingly familiar.

Originating in Weimar in 1919 (and later moving to Dessau, Berlin, and Chicago), the Bauhaus was less a formal academy than it was a spirit shared among inspiring individuals. They were committed to experimentation with forms of materials, and they attempted to integrate their ideal of an unornamented, streamlined, yet energetic design principle with the world that was then opening up through new technologies.

Among themselves, they erased traditional distinctions between fields of endeavor, as well as between "fine arts" and "crafts," subsuming all the arts and design under the queenly concept of "building," that is, architecture.

Other crafts movements of the time looked backward, to a rural utopia of handmade objects, while other futurist artistic philosophies tended to celebrate extremes of speed, violence, and mechanization, or else a kind of otherworldliness. The Bauhaus was unique in keeping the function and place of humanity in view while accepting the practical demands and opportunities inherent in new materials and manufacturing methods.

The members of the Bauhaus learned from each other as much as they taught their own students. Such cross-fertilization helped to create a sense of unity across work by very different people involved in very different activities.

One of the unusual features of the current exhibit at M.I.T. is a display of work by Bauhaus students, mostly three-dimensional design and composition experiments. Sometimes crudely joined or finished but always spatially elegant and vivid, these seldom-seen pieces give the viewer a real feeling for what the day-to-day activity in the Bauhaus course would have been like.

The exhibit's focus on the work is appropriate enough; though many theories of color, design, and movement sprang from Bauhaus studios, it was primarily a practice-and-workshop-oriented school.

The texts posted throughout the exhibition areas seem to be adapted from Hans Wingler's magisterial volume *The Bauhaus* (M.I.T. Press, Cambridge, MA and London, 1969, 1976). They are clear and concise, and are artfully divided among different personalities, programs, and periods of time.

A valuable and thoughtful addition to the show is a small library of illustrated books on Bauhaus figures. These aren't the usual books-under-glass, but are references meant to be used by the viewer to amplify areas of personal interest. Two Breuer-design chrome-and-leather chairs are waiting nearby, to encourage browsing.

The illustrative placards are eye-catching and interesting; the narrated slide presentations are stylishly done and repeatedly shown in dim alcoves provided with seating. One of the pleasures of the M.I.T. Museum is its amiable, undiscovered quality, and the freedom one feels to wander at will. The arrangement of this show encourages that feeling.—*Tom Frick* □

ROBERT CAMPBELL is the architecture critic of the Boston Globe. *His column is reprinted with permission. TOM FRICK is an art critic who also wrote on the Bauhaus exhibits in the* Boston TAB.

Fine-Tuning Goals and Image, and Bringing the Troops Up to Speed

Two initiatives with the potential to alter the fact and the image of an M.I.T. undergraduate education were previewed for 250 alumni and their guests attending the National Alumni Conference (NAC) in Costa Mesa, Calif., last fall.

Studies of the undergraduate curriculum that are now undergoing intense faculty review are expected to lead to changes that "reach into the intellectual and social fabric of the Institute," said Professor Jack L. Kerrebrock, associate dean of the School of Engineering.

Meanwhile, said Michael E. Behnke, director of admissions, he and his associates are implementing major efforts to "communicate more effectively the breadth and choice that exist at M.I.T." Their goal, he said, is to ensure that M.I.T. will have an undergraduate student body in which great diversity of academic and non-academic interests is the norm rather than the exception.

Both these thrusts were cited by Joseph G. Gavin, Jr., '41, president of the Alumni Association (AA), as fruits of what he considers the Institute's's greatest single asset—the power and energy that stand behind its programs. M.I.T. may sometimes seem to move slowly, said Gavin—like a river of lava. But like lava, too, it has uniquely powerful inner resources.

The West Coast conference was rewarding for participants and organizers alike, according to Webb Elkins, director of alumni relations and secretary of the AA. It attracted both seasoned alumni volunteers and scores of new recruits interested in becoming more involved in M.I.T.'s outreach to graduates.

In an update of the traditional NAC format, workshops geared to the interests of young alumni and career changers of all ages were added to briefings for educational counsellors, fund raisers, and club leaders. There was also a full day of reports on innovations from M.I.T.'s Media Laboratory.

Alumni represent one of the Institute's vital resources, and the NAC sought at once to celebrate and cultivate their strength.

To celebrate it, Harris Weinstein, '56, chairman of the Alumni Fund Board, reported a 1986 fund total of $11.2 million—up from the $10 million raised in the previous year. Indeed, said Weinstein, the last decade has been a period of "remarkable progress," with the fund achieving a compound annual growth rate of 9 percent—or 7 percent in constant dollars. In the last five years the number of donors making gifts of $100 and more has climbed from 22 to 34 percent, and there has also been a "gradual but steady increase" in donors of $1,000 and more (more than 900 in 1986).

But, said Weinstein, as the Institute prepares for a major capital campaign to substantially increase its endowment resources, the Alumni Fund is challenged to accelerate its progress. The goal is a compound annual growth rate of 10 per-

cent leading to a $20 million annual fund by 1992. To achieve that, said Weinstein, he and his Alumni Fund Board colleagues are charting a course that would increase the median gift from $50 to $100 by 1992, substantially increase the participation in the fund by alumni who hold only graduate degrees from M.I.T., and increase the role of volunteers by establishing personal solicitation programs throughout the country.

Honors and Awards

In further celebration of the strength of M.I.T.'s alumni support, Gavin announced the major 1986 awards for service by alumni to M.I.T.:

□ George B. Morgan, '20, Awards for "sustained excellence in work for the Educational Council" to **Dwight Taylor,** '26, of Franconia, N.H.; **Louis Stouse, Jr.,** '42, regional EC chairman in Greensboro/Winston-Salem, N.C.; **R. Maurice Tripp,** Sc.D.'48, of Santa Clara, Calif.; and **George Palo,** '28, regional EC chairman in Knoxville, Tenn.

□ Harold E. Lobdell, '17, Distinguished Service Awards for "outstanding service of special depth in one activity or substantial and sustained along broad lines" to: **Noel S. Bartlett,** '60, for his support of the M.I.T. Club of Cleveland, the Class of 1960, and the Alumni Fund; **Alan W. Burke,** '20, class agent for the Class of 1920; **Ernest M. Cohen,** '64, for leadership of the Black Alumni of M.I.T. (BAMIT); **Edgar P. Eaton, Jr.,** '44, for leadership in the Class of 1944; **Bruce Hartenbaum,** '59, for fund-raising efforts in Los Angeles; **Leslie C. Hruby,** S.M.'73, for leading alumni activities for graduates of the Sloan School of Management; **Harbo P. Jensen,** Ph.D.'74, a key volunteer in the San Francisco area; **Thomas W. McCue,** '29, an "extraordinarily dedicated" participant in Alumni Fund telethons; **William C. Morris,** '60, for leadership in the M.I.T. Alumni Center of New York; **Antonia D. Schuman,** '58, for work in Southern California and with the Association of M.I.T. Alumnae (AMITA); and **Wendyl A. Reis, Jr.,** '56, for service to M.I.T. clubs in Texas and New York and to the Enterprise Forum of Texas.

(Facing page): Paul Gray, '54, salutes the Class of 1947, (from left) Martin Schwartz, Claude Brenner, and Arthur Schwartz. (This page, clockwise from top left): (Left to right) Director of Admissions Michael Behnke continues his discussion of new policies with Gary Schweikhardt, S.M. '73, and Maxwell Coutts, '39. Harris Weinstein, '56, reports a 1986 Alumni Fund of $11.2 million. AA President Joseph Gavin, Jr. '41 (right) congratulates Bronze Beaver winners (from left) Dubose Montgomery, Jr., '71, Robert Muh, '59, and Henry Lippitt II, '36. Glenn Strehle, '58 (right) vice-president for resource development and treasurer, chats with fellow alums.

PHOTOS: TOM SULLIVAN, JOHN MATTILL

M·I·T in Southern California

(Left) Stephen A. Benton, '63 (center) displays a hologram in the bright California sun, as part of his presentation on "Computing for the Senses." (Photo at right, from left) Melford Monsees, '58, with Jack Kerrebrock, associate dean of engineering.

☐ Presidential Citations to acknowledge the successes of alumni organizations and activities were made to: **AMITA** for its 11-year-old IAP symposium for women students on "Getting the Job You Want in Industry: a Women's Guerrilla Guide to the Pin-Striped World"; the **Class of 1960 Reunion Gift Committee,** which raised a record $1.96 million from 67.5 percent of the class to celebrate its 25th reunion; **the M.I.T. Club of Colorado** for its "Mini-College Weekend" series combining seminars and recreation in the Colorado Rockies and to the two-year-old **M.I.T. Enterprise Forum of the Northwest,** which has succeeded even beyond the high standards of other Enterprise Forum groups in attracting favorable attention for M.I.T. while providing valuable counsel to emerging technology-based companies.

☐ Bronze Beaver Awards—the highest that can come to alumni for service to M.I.T.—were announced by Gavin for **John F. Taplin,** '35; **Henry F. Lippitt II,** '36; **Charles H. Spaulding,** '51; **Robert A. Muh,** '59, **Bill C. Booziotis,** M.Arch.'60; and **H. Dubose Montgomery, Jr.,** '71. Their citations appear in the "Courses" and "Classes" sections of this issue.

Professions in Society

In one of the key reports of this year's NAC, Kerrebrock described three studies of M.I.T.'s undergraduate programs in engineering, science, and the humanities, prepared under the general direction of Professor Margaret L. A. MacVicar, '65, the Institute's first dean for undergraduate education. The studies resulted, he said, from a "growing consensus among the faculty on the need for a broader experience for undergraduates." Though how it will be achieved remains to be discussed, Kerrebrock thinks the objective is clear: to integrate the experiences of undergraduates so as to enrich their understanding of their professions as part of a social system.

Kerrebrock's role in this process was to chair a Commission on Engineering Undergraduate Education that articulated a set of goals for an M.I.T. engineering education:

☐ A firm foundation in science and mathematics.
☐ A working knowledge of the current technology in one's area of interest.
☐ An understanding of "the diverse nature of human societies." (Don't think of this as a kind of "secondary enrichment," Kerrebrock told the alumni; it's a fundamental part of the education we want to provide.)
☐ Preparation for lifelong learning.
☐ Experience in cutting-edge research.
☐ Understanding of design as a process of engineering synthesis.
☐ Communication skills.
☐ Awareness of the environmental and social issues surrounding technological developments.

Though Kerrebrock's enthusiasm was clear, it was evident from their comments that some alumni have strong reservations about the proposed change of focus.

Capitalizing on a "Rich Mosaic"

Behnke's presentation, enlivened by a new video presentation about M.I.T. designed for high school students and their families, provoked considerable interest. "Too many people," he said, "think of M.I.T. as a place where socially maladjusted white males come and study engineering all the time." The reality is very different, said Behnke—the Institute offers a "rich mosaic" of programs and activities that are appropriate for students with many interests and career objectives.

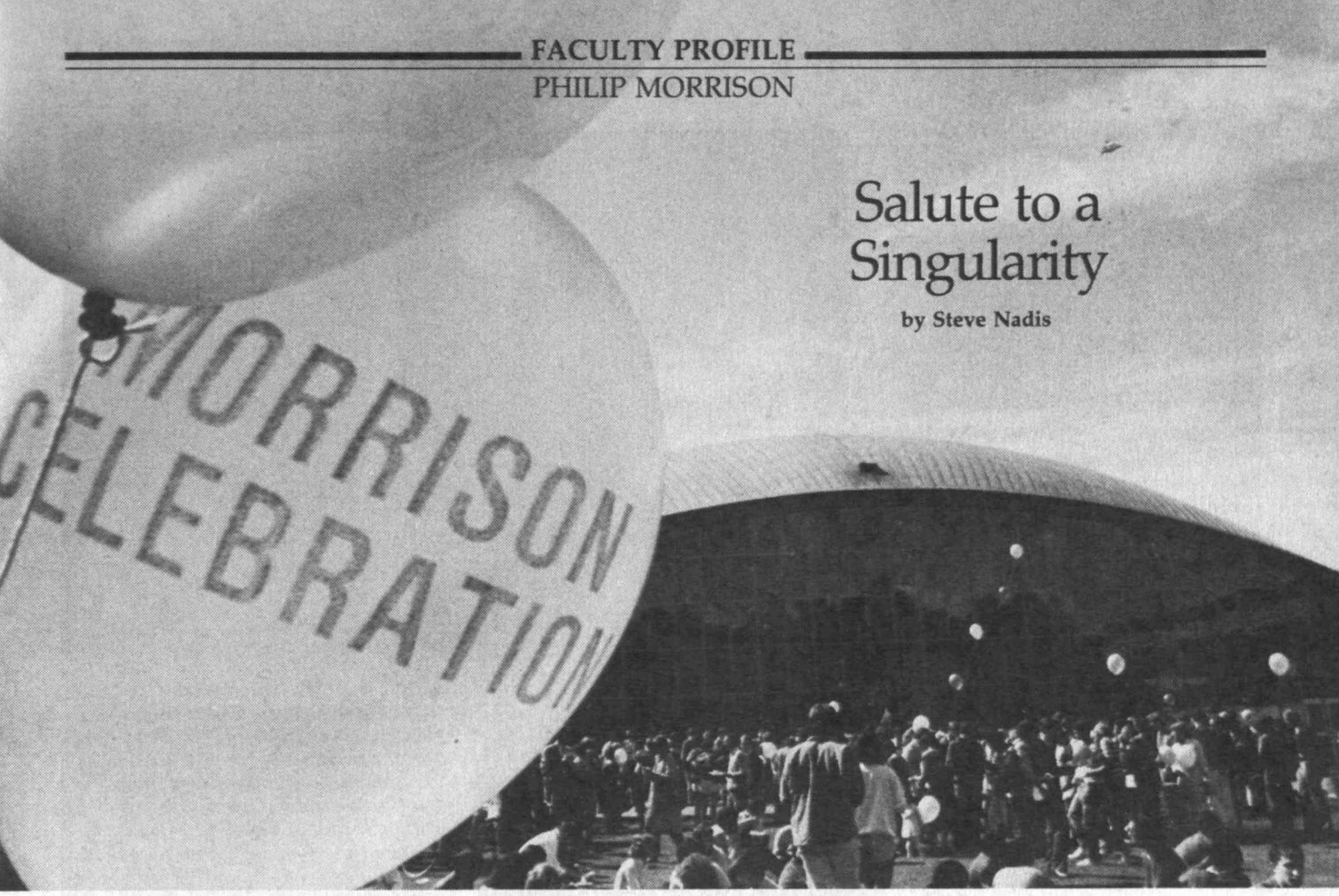
One example: Behnke and his associates want to achieve a better balance in curriculum choice, reducing the proportion of each class that ultimately chooses to major in engineering while increasing undergraduate enrollment in such fields as management, economics, and political science. Another goal is to continue to increase the diversity of students—more women, more minorities.

Though Kerrebrock and Behnke said that, for the moment, their initiatives are basically unrelated, President Paul E. Gray, '54, linked them in his address concluding the conference. The Institute, he said, embraces a range of fields and activities especially relevant to today's concerns about the societal impact of technology. And it brings to Cambridge a remarkable group of young people as students. Together, these circumstances, said Gray, give M.I.T. a singular opportunity and responsibility.

And continued—and even intensified—alumni support will remain crucial to its response.—*John Mattill* ☐

Salute to a Singularity

by Steve Nadis



I'm quite used to getting old," Nobel Prize-winning physicist Hans Bethe told an audience at Kresge auditorium. "But it's very depressing if young people get old too. When I met Phil Morrison, he was 28, a very young man. Now they tell me he is 70, which is hard to believe. But one thing remains unchanged—he always gave us terribly exciting ideas and insights, and he is still at it today."

Bethe spoke at a two-day symposium held last September in honor of Philip Morrison, an internationally renowned astrophysicist.

Morrison, who was named Institute Professor of Physics in 1973, has won many prizes throughout his career, including M.I.T.'s Killian Faculty Achievement Award for 1984-1985. He is the author of several textbooks, more than 75 scientific articles, and an equal number of articles for a general audience.

As the symposium's final speaker, Morrison thanked the audience for a standing ovation, a 20-second interval he considered "not only warm, but also free from hyperbole, which was not true of all the other things we heard today. I wish I had done some of those fine things that people said I did."

He added, jokingly, that "in celebrating my 70th birthday on this date, the organizers of the event took some liberties." In fact, they missed it by almost a year. "Depending on how you calculate it, 10 percent off or 1.5 percent off," he said, "and either of those are good enough for our trade."

"Science is not purely a cerebral affair; it is soaked with emotion, excitement, and nervous tension."

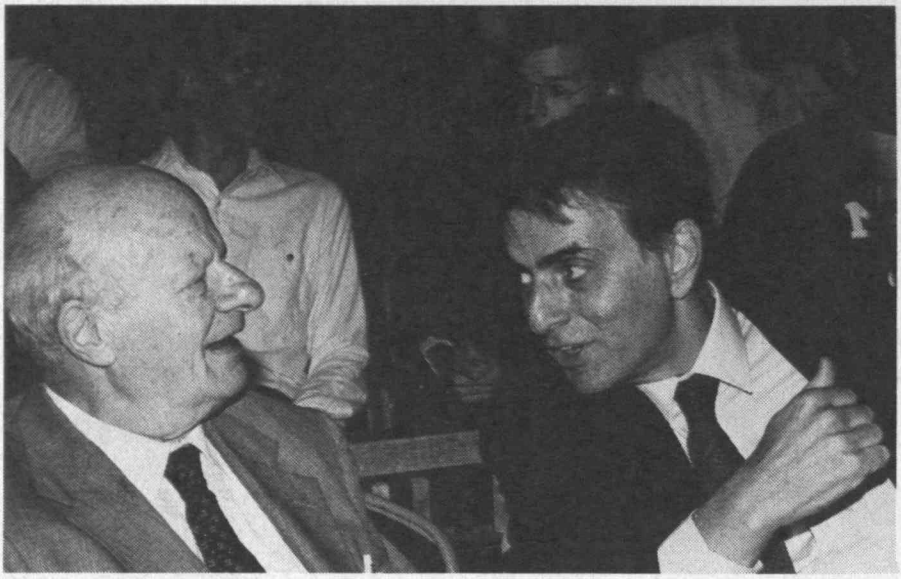
The event, called "The Worlds of Philip Morrison," revolved around three of Morrison's main areas of interest: astrophysics, education, and nuclear disarmament. A magic show, balloons, and kites were also included to emphasize his admiration for "playful science and engineering."

Morrison was born in Somerville, New Jersey in 1915 and began playing with science and engineering at a time most children are content with toy trucks and blocks. For his fifth birthday, he received a crystal radio set from his father. "I became a radio enthusiast from the age of five," he said. "Maybe that is responsible for whatever else happened to me. I don't know."

When Morrison was seven, he and some other kids built a receiver and transmitter at the local radio club. "I can't say that it worked," he said, "but it looked quite impressive."

Morrison entered college with hopes of becoming a radio engineer. "I only had to go to six lectures in electrical engineering and six lectures in physics to see that my heart belonged with the physicists," he said. "The subject matters might have been much the same, but the attitude, the community in which I could see myself working, was so different. Physics was exploratory, seeking, grasping, not satisfied with mere compact results. And it was so much more my style that I became, for better or worse, a physicist." He received a B.S. from the Carnegie Institute of Technology in 1936 and a Ph.D. in theoretical physics from the University

PHOTO: L. BARRY HETHERINGTON



(Top, from left) Hans Bethe and Carl Sagan, well-known physicists and educators from Cornell University, and (left) Randall Forsberg, executive director of the Institute for Defense and Disarmament Studies in Brookline, Mass. were among the colleagues and collaborators of Philip Morrison who spoke at the symposium in his honor. (Facing page) Phylis and Philip Morrison make the first cuts in a spectacular "Institute in cake" that served the hundreds of people who gathered on the Kresge oval for the birthday festivities and kite festival in Morrison's honor.

of California at Berkeley in 1940.

Morrison went to the University of Illinois to teach physics just as World War II broke out. He joined the Manhattan Project and played a key role in designing the plutonium core of the first atomic bomb. On July 12, 1945, he traveled 200 miles across the New Mexico desert to the Trinity test site sitting in the back seat of a Pontiac with the bomb's core.

"By the heat I felt in my face during the Trinity test at 18,000 yards, I was pretty well committed to doing something about putting the bomb into a proper situation," Morrison recalled. In 1948, he was a founding member of the Federation of American Scientists, an organization established to advocate a sound nuclear policy, and he has been a leader of the arms control movement ever since.

Morrison joined Cornell's physics faculty in 1946, where he remained until coming to M.I.T. in 1964.

In the early 1950s, Morrison's focus shifted from particle physics and electrodynamics into astrophysics. "It was an exciting time," he said. "There were many new results, and we were close to the ground floor. It seemed like a great opportunity."

Morrison began by investigating cosmic rays, space-born particles that bombard the earth's atmosphere. "I realized we could learn something about astronomy by following (the particles) back to where they came from," he said. "And as we followed them back through the solar system and stars, we got somewhat lost from cosmic rays and found x-rays, radio waves, and many other things. That was the beginning of the sense that we should indeed study radio astronomy as well as optical, and of course now the whole gamut."

Inventing a Whole Field

In 1958, Morrison wrote the first paper ever written on gamma ray astronomy. "He basically invented the whole field," commented Boston University astrophysicist Kenneth Brecher, '64, who also spoke at the symposium.

A year later, Morrison co-authored a revolutionary article with Cornell colleague, Guiseppe Cocconi, on SETI—the search for extraterrestrial intelligence. It was the first serious treatment of the subject.

At the time, according to Carl Sagan, another speaker at the conference, the general public regarded SETI as "somewhere between science fiction and hokum." Morrison and Cocconi confronted the skeptics with a practical search strategy. They suggested, as a first step, that we listen closely, tuning our receivers to the microwave spectrum—that being the most logical range for interstellar communications. They even suggested likely frequencies to listen for, so-called "magic frequencies" such as a 1420 megahertz (the emission band for hydrogen, the most abundant element in the universe.)

Since the publication of that pioneering paper, "Phil Morrison has played a central role in the increasing respectability of the subject," Sagan said. In the two major searches currently underway—one conducted by NASA and the other by Paul Horowitz of Harvard—he has provided "inspiration, insight, and motivation."

During the symposium, Morrison's contribution was acknowledged by the NASA-SETI group with an engraved shovel that read: "Happy 70th birthday to Phil Morrison, from those of us trying to build a better shovel for the archaeology of the future."

How the search will turn out, no one knows, Sagan said. If we find nothing after decades of diligent searching, at least we will have some appreciation of the rarity of intelligent life. "If, on the other hand, we do receive a signal, there is no doubt that we would owe the greatest debt of gratitude to Phil Morrison.

"I don't want you to think this openness to new ideas is untempered in him," Sagan told the assembly of scientists and M.I.T. students. "There is

also a very appropriate dose of scientific skepticism which can be seen in his famous remark, 'I will believe a black hole when I see one.' And it is exactly this tension between openness and skepticism that is one of Phil's great virtues."

During the time when the Bermuda Triangle was accused of "eating" ships and airplanes, Morrison reportedly asked "Why aren't trains being eaten?"

In the 60s, Sagan arranged a meeting between Morrison and James MacDonald, a respected astro-physicist who gave some credence to tales of UFOs visiting earth. After MacDonald talked with the skeptical Morrison for 15 minutes, "the balloon (of MacDonald's belief) was punctured," Sagan recalled. "In so doing, Phil did us all a great service."

Unforgettable Lectures

Commenting on Morrison's remarkable ability as a teacher, Sagan said his influence at Cornell is "still palpable," even though he left the university more than 20 years ago. "People who've attended his lectures never forget them."

In another tribute to Morrison's teaching written 10 years ago (*Technology Review, June 1976*), which was read during the symposium, Victor Weisskopf said, "Scientific knowledge and understanding is not a purely cerebral affair; it is soaked with emotion, excitement, and nervous tension, as everybody knows who has heard Philip Morrison talk. . . . If you need a proof that true science is not a dry and impersonal subject, go and listen to Phil."

Physics professor Anthony French recounted an experience Morrison had as a graduate student. "This is a difficult course," the instructor said. "There are many theorems to be introduced. If you ask questions, we'll never get through."

"I can't think of a greater antithesis to Phil's mode of operation," French commented. "He is forever inspiring speculation and questions."

By working in so many different areas of science, Morrison is "the best counter-example to the narrow specialists of today," Weisskopf noted. "Phil's strength is the broad-brush painting of the scientific landscape. You learn the great connections, the deep relations, and the far perspectives.

"The life of a scientist would not be worthwhile were it not for those few moments when he feels an exhilarating joy, deep in his guts, of having understood something, of having seen new connections that bring things together. In my life, more often than not, such a moment happened during a conversation with Phil."

Morrison's enthusiasm for science is contagious. Kenneth Brecher, who earned a Ph.D. under Morrison's tutelage and later went on to collaborate with him, recalled their first encounter: "I met Phil 20 years ago, when he taught an undergraduate course in the base-

PHOTOS: L. BARRY HETHERINGTON; NINA TOVISH

"I can't avoid the feeling that we have a responsibility to act, as we have a responsibility to know."

ment of Kresge on theoretical physics. Like everybody else, I was absolutely enthralled. I became a student of Phil's, which I've been ever since."

Jerrold Zacharias, the late, much-loved physicist and Institute Professor, pushed Morrison into "the wider spectrum of education," away from simply educating physicists and college students and into high schools, elementary schools, magazines, and television.

As book editor for *Scientific American*, Morrison has reviewed close to six books per month for the past 25 years. His reputation as a reader and his voracious appetite for books are legendary.

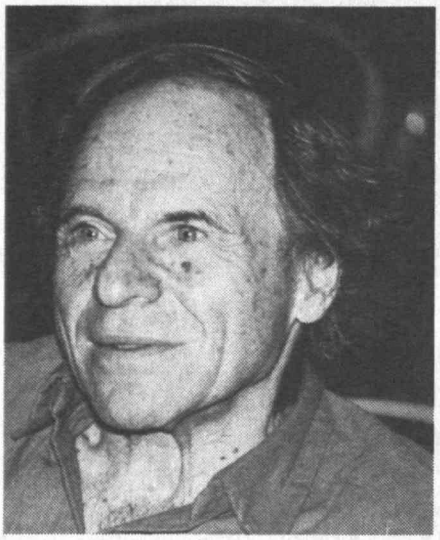
"Have you ever seen him 'read' a book by turning a page every one or two seconds?" Weisskopf asked. "He knows the content and, what's more, he knows the significance and relevance of it. This fact has been experimentally tested."

"I think it's fair to say that many people learn more from reading his reviews than from reading the books," Sagan added. "There is a kind of condensation down to the essence of things that is hard to extract oneself in reading the book. These reviews are also marked by a generosity of spirit in which insights are attributed to the authors that they never had—they're just Phil's!"

Each December, Morrison and his wife Phylis review 30 children's science books in *Scientific American*. He has devised elementary school curricula and written a high school physics text. "A lot of physicists know a good deal about sold-state manufacturing," he said, "but they don't know anything much about the schools and how they work."

The Best Science Film Ever Made

To reach a broader audience, Morrison has also ventured into the world of television. He worked on half a dozen shows for NOVA and other programs as well. One film, "Powers of Ten," produced with his wife and with Charles and Ray Eames, is "the best science film ever made," according to Brecher. (It is used in astronomy courses at all levels worldwide.)



Brian Moser, '87, who presented Morrison with a kite on behalf of the M.I.T. student body, explained how his life had been affected by watching a Morrison lecture on television: "I was a sophomore in high school. My parents called and said, 'Brian, there's some crazy physicist on TV!' I became excited about M.I.T. and college for the first time."

Morrison is currently making a six-part television show called "The Ring of Truth," a portion of which was shown at the symposium. The series, which will be aired on PBS, will attempt to show how science works and how scientists determine which ideas "ring true." In presenting the film clip, producer Michael Ambrosino said, "It's essential that the best scientists spend time speaking to the public, because if the best scientists don't, others will."

Morrison, however, is not content simply to educate. He is also a devoted activist, particularly on the issue of nuclear disarmament. "I can't avoid the feeling that we have a responsibility to act, as we have a responsibility to know," he said near the end of his lecture. He asked for signatures on a letter to retiring House Speaker Tip O'Neill calling for a nuclear test ban, an anti-satellite weapons testing ban, and adherence to the SALT II treaty limits.

Morrison has been a tireless critic of the strategic arms build-up. From 1973 to 1976, he was chairman of the Federation of American Scientists. From 1975 to 1979, he was a member of the Boston Study Group, a collection of Boston-area academics whose thinking on defense policy resulted in the 1979 book, *The Price of Defense*, later published as *Winding Down*.

The Price of Defense—written by Morrison, Phylis Morrison, Randall Forsberg, Paul Walker, Martin Moore-Ede, and George Sommaripa—called for massive reductions in the U.S. nuclear arsenal—a move that would, in the authors' view, save money and enhance security. "The book was ahead of its time," Sagan commented. "I think that time is coming."

The book evolved from weekly discussions held over dinner, "which usually meant pizza," Forsberg said at the symposium. "We thought of calling it *The Pizza Papers*."

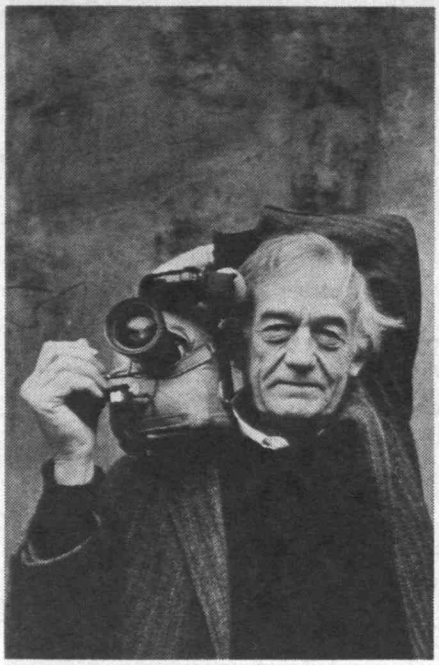
What Paul Walker remembered vividly was the way Morrison treated everyone in the Boston Study Group, (several of whom were only graduate students at the time) as equals, "even though he was by far the most senior."

"Phil brought to our discussions an essential element of humanity—an extraordinary sense of realism in dealing with the world as it is today," Forsberg recalled.

Morrison responded that "it is very good to have a measured and realistic view, but it is also very good to extrapolate from what people think is possible next year into some vision of the future. Without vision, the people perish."

Sagan summed up the two-day symposium with a tribute: "Phil has helped students, colleagues, and many readers 'join the universe' but he has also helped people all over the world, many of whom may never have heard his name. His kindness, his generosity of spirit, his insights, his enthusiasm, his social concern have made him a model for other scientists in the rare art of becoming a fully developed human being." □

PHOTO: L. BARRY HETHERINGTON



Richard Leacock, professor of film and the man credited with developing the technologies of cinema verite, received the 1986 Eugene McDermott Award at the 15th annual meeting of the Council for the Arts in October. The award is presented yearly to honor major contributors to the arts. Leacock's citation notes that he has "made M.I.T. the best place to learn how films can and should be made."

Arts Review

A major review of visual and performing arts programs at M.I.T. has been commissioned by John M. Deutch, '61, provost, with "the expectation that it will lead to more resources being devoted to the creative arts," according to a report in *Tech Talk*.

The review will be carried out by an ad hoc committee composed of faculty and outside experts. Committee chair is Paul L. Joskow, professor of economics, and the deputy chair is Henry Millon, a visiting professor in the M.I.T. architecture faculty who is now dean of the Center for Advanced Study in the Visual Arts at the National Gallery in Washington.

"It is becoming increasingly apparent," Deutch has observed, "that both the successful implementation and the responsible use of technology in our society require attention to an entire range of considerations beyond those that are purely technical. These considerations include aesthetics and social sensitivity as well as the more obvious concerns in economics and politics.

"The result is that the attitudes and interests of the technically educated person are changing," Deutch said. Students are eager to observe and participate in the arts, as well as explore the relationship between the arts and technology. And M.I.T. "will need to attract more students and faculty who have these broader interests as a central part of their academic or professional lives," Deutch said.

To address that need, the arts review will focus on three ways to strengthen the role of the creative arts: establishing a new goverance system for the arts at M.I.T.; enhancing academic programs in the visual and performing arts (both practice and criticism); and broadening the role of the arts on campus.

When the arts review committee has completed a one-year appraisal, its recommendations will form the basis for a number of new programs and experiments, some of which Deutch expects will be incorporated later into the ongoing arts program at M.I.T. □

Investments Climb, But So Do Needs

Lifted by strong equity and bond prices, the market value of M.I.T.'s investments soared nearly 30 percent to exceed $1 billion for the first time in the Institute's history during the 1985-86 fiscal year. At the end of the year, last June 30, the total invested funds stood at $1,176 million, compared with $921 million a year earlier. Of the 1986 total, endowment funds were $971 million.

At the same time, a surplus of more than $1.5 million in unrestricted funds remained available on June 30, 1986. Present estimates forecast a slightly larger surplus of $1.9 million from 1986-87 operations, according to James J. Culliton, vice-president for financial operations, and Glenn P. Strehle, '58, vice-president and treasurer, in their annual report to the M.I.T. Corporation.

Gifts, grants, and bequests to the Institute reached $54,783,000 in 1985-86, lower than in 1984-85, when the total

Alumni Press for Divestment

An escrow fund "designed to pressure M.I.T. into selling its shares of corporations doing business in South Africa" is now receiving contributions from alumni.

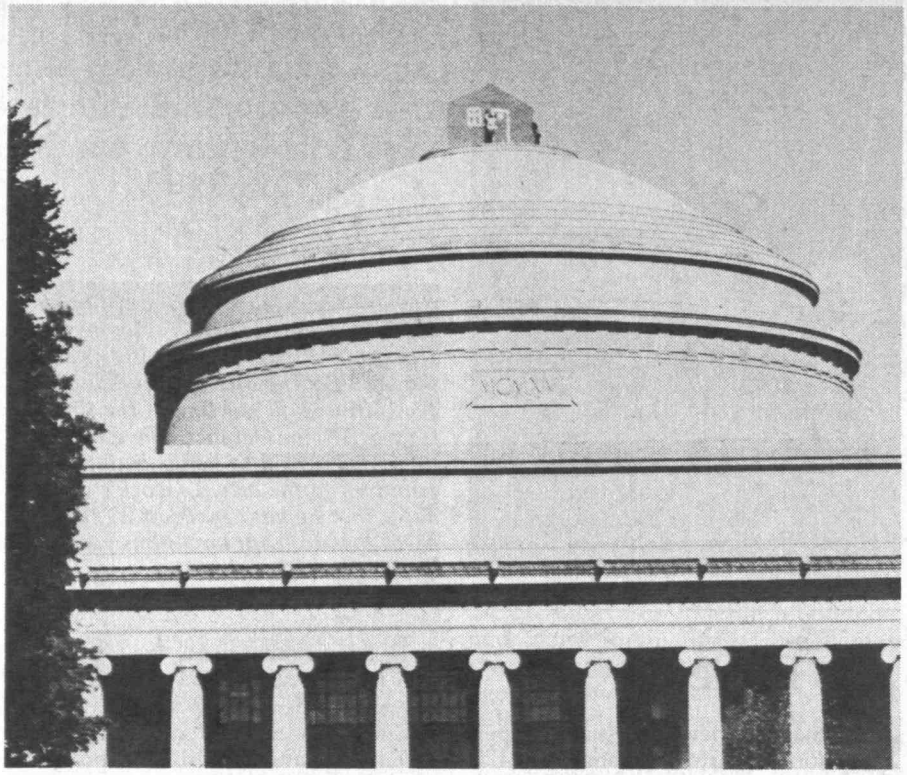
The Endowment for Divestiture, a charitable trust, will retain alumni contributions in escrow "until the M.I.T. portfolio is free of South-Africa-related investments." If divestment is not complete by 1994, the contributions will go to Amnesty International and the United Negro College Fund instead of to M.I.T.

Willard Johnson, professor of political science who is a member of the endowment's board of trustees, explains that "alumni can contribute to the endowment as an expression of loyalty to M.I.T." while showing "concern for the moral and ethical standards of the Institute." His colleague, Melvin H. King, adjunct professor of urban studies and planning who directs the Community Fellows Program, calls on M.I.T. alumni to "take a stand against the moral disgrace of apartheid and for the fundamental human values of equality, liberty and dignity."

Other members of Endowment for Divestiture's Board of Trustees include Congressmen Bruce Morrison,'65 (D-Conn.), and Howard Wolpe, Ph.D.'62 (D-Mich.); Professors Gretchen Kalonji, '80, John Parsons, and Joseph Weizenbaum; and John Carlos Correa, '81, Philip Katz, '82, and Marc Miller, '69, all of the Greater Boston area. □

PHOTO: COUNCIL FOR THE ARTS

Members of the Technology Hackers Association were discovered by Campus Police before they could complete construction of a 16-foot-square shack on top of the Great dome.



was a record $61,714,000. The decline was attributed by Culliton and Strehle to a decrease in nonrecurring grants from trusts, estates, and charitable foundations. Individual giving was up almost 16 percent in 1985-86, led by a 259 percent increase in gifts to life income plans—a high of $4,945,000.

While the market value of its funds stood at a record high, so did the Institute's demands on fund income. Indeed, M.I.T. used $16.4 million of investment income to meet current expenses in 1985-86, up almost 18 percent from the previous year. Thus Culliton and Strehle emphasized in their report that M.I.T. "continues to face critical financial issues that require increased endowment if they are to be resolved." They cite three:

☐ The need to devote a major portion of unrestricted gifts, grants, and bequests to meet the expenses of current operations, reducing the amounts that can be added to endowment.

☐ The reliance on income from sponsored research to meet two-thirds of annual operation expenses.

☐ The continued need to use operating revenues to build or buy and remodel buildings for academic use.

"Among those major universities with which we compare," wrote Culliton and Strehle, "our endowment is the smallest in relation to operating expenses." ☐

Little House on the Dome

Room 10-1000, a 16-foot-square plywood shack that was the most recent ambitious undertaking in the history of the Technology Hackers Association, caused lots of second glances at the Building 10 dome on Registration Day, 1986.

Members of the THA and "friends," all of whom remained anonymous, explained that the shack was assembled on the dome of prefabricated plywood sheets between midnight and 5 a.m.

Earlier, some 30 students had worked to gather and prepare the materials—a total of 28 plywood sections and pieces of 2 x 4. They were hauled to the roof by what THA called "brute force"—first to the roof of Building 13 and then on up the dome. The structure was secured to the dome with steel cables and rope. Windows and a door, complete with the room number, were painted on its walls.

The project was discovered at 5 a.m. by Campus Police, even before THA had finished the last details. Later, the hackers volunteered to help remove their creation, but Physical Plant accepted no help. Chief James Olivieri issued the hackers a "one-event amnesty" from the $50 fine that can be levied on anyone who trespasses on an M.I.T. roof. ☐

Tenure Suit

David F. Noble, formerly associate professor in the Program in Science, Technology and Society who now holds a similar post at Drexel University, Philadelphia, has filed suit against M.I.T. for failing to grant him tenure in 1984.

Noble's suit requests the Middlesex Superior Court (Massachusetts) to order M.I.T. to appoint him "to the position of tenured associate professor in the School of Humanities, retroactively effective to February, 1984;" or to reconsider his tenure case and pay $1.5 million in damages. Noble contends that he was not granted tenure because of writings that were critical of the Institute.

M.I.T. has issued a statement through the News Office saying that the Institute is "confident that the decision of Mr. Noble's peers against granting him tenure was proper and will be upheld in a court of law." ☐

PHOTO: STEPHEN BERCZUK, '87, FROM THE TECH

15

So, it is the beginning of 1987, '15ers. Happy New Year to each and every classmate!

Tidings from **Francis Hann**, wherein he states: "It is imperative! One must stay right on top of any well finished work, as you know, Joyce, and have proven it over the years." Thanks very much, Francis. . . . A delightful note from Marilyn Christopher, **Franklin Myrick**'s daughter, states how Franklin looks forward to letters and enjoys the news of the "old gang," as well as hearing about my activities. Franklin's wife had a stroke, then broke her hip, and passed away. Now Franklin has moved into a 9-year-old bi-level with lots of space and a glorious vision of the Appalachian Mountains. He loves his new surroundings, and his new life-style includes three entertaining poodles named Becky, Buddy, and Boomer, otherwise known as the three Bs. He also enjoys TV news and keeps up with the stock market. Marilyn and her husband John have a very special relationship with Franklin and are grateful for the wonderful time they are having with him. They especially enjoy watching sunsets and taking walks together. Franklin will celebrate his 95th birthday on February 16, 1987!

My "always faithful" **Ellis Ellicott** comes through with a fine typewritten note. He is now 94 and plans to attend a family reunion in Deer Isle, Maine. Instead of flying, Ellis's son, Charlie, will drive—a 900-mile trip. Ellis still is living alone, thinks it would be wise to make a move, but the problem of closing up a house and distributing the contents appalls him. He visited his heart specialist and seems to be holding his own beautifully. He is so glad his eyes are holding up well, says he would be a lost soul if he wasn't able to read.

Ellis still does his own grocery shopping, has discovered a new food market, and mentioned lobsters from Nova Scotia. What a treat! He is acquiring great-grandchildren, now totaling six, and sends birthday cards to all. He purchased a little Japanese Tercel a year ago and found it very satisfactory. However, not long after he purchased it, the car was stolen. It fortunately was recovered with minimal damage.

I have talked to **Bob Warren** on the phone occasionally, and he has been at his summer home this year (1986) and keeps abreast of the stock market. One time when talking to him, he was on his way to pick up a lobster for his dinner. These lucky people!

I received a letter from Norm Nathan, WBZ radio, in Boston, No. 1030 on the dial. I had suggested to Norm the possibility of interviewing **Mimi Plummer Rice**. He replies that it would be very interesting to get in touch with Mimi in California and talk with her about life at M.I.T. back in the teens. I intend to contact Mimi soon. If and when we can set a date for this interview, I will certainly get in touch with each '15er so that you may tune in WBZ. It will definitely be on a Saturday evening, and after midnight. I am hoping that when I make the arrangements I will be able to give you the exact time, so you can all be bright eyed and bushy tailed!

As always, let me hear from you—the terrific gang!—**Joyce E. Brado**, Class Agent, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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Stan Dunning reports that he has heard from two classmates. **Ossie Holt** sent a long letter with pictures. "He surely looks well for a man who has had the physical troubles he has had," says Stan. Ossie is not waiting for 1987 to visit M.I.T. He is planning to spend a month in the East this fall and wants to visit the campus. He has asked for a guide to help him get around and has been advised that there will be one available. . . . **Enos Curtin** is still a New Yorker. He puts up with some of those limitations that most of us have, says Stan.

Ossie Holt

Stan reports that he gets around his Concord, N.H., retirement home well on his walker, but a heart, breathing condition limits his activity.—*ed.*

18

As you all know, we are one of 341 families in the retirement colony called North Hill in Needham, Mass. One of the activities which helps to challenge the minds of the residents here is a series of evening meetings patterned after the Boston Seminar Series at M.I.T. for its alumni. I helped to start this program, which has been quite successful at the Cambridge campus. I have been instrumental in repeating this activity here. Last year we had the pleasure of hearing M.I.T. Professor Philip Khoury lecture on the Near East and Professor Peter Smith similarly on Mexico. Both meetings were successful and stimulating.

Soon we will have the pleasure of continuing the M.I.T. contacts with an evening meeting, featuring Professor Robert Rotberg on Africa, followed in November with Professor Myron Weiner's description of what is going on in India.

About a week ago Selma and I had a brief chat with **Lenny Levine**, as we were both waiting to meet our doctors.—**Max Seltzer,** Secretary, North Hill, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

Carl L. Svenson's daughter, Ms. Martha Shafer, writes that he died on July 31, 1986, of complications following open heart surgery in May. Our contacts with Carl were at class reunions, and they leave us with pleasant memories.

In the last issue of the *Review*, we reported the death of **Louis Grayson**. Meantime, thanks to the Alumni Association, we have received a New England newsclip that tells of his founding of the Grayson and Dickinson Insurance Agency in Washington, from which he retired in 1972 after 40 years as the senior partner. He served in the army air forces during World War II. He was president of the District of Columbia Underwriters Association and treasurer of the National Association of Life Underwriters. Like so many of our classmates, he lived a long useful life, and we can all be proud of him.

Finally, in this issue we must tell you of the death of **Karl Locke Nutter** on August 15, 1986, at the North Hill Retirement Center in Needham, Mass. His nephew, Mason Hartman, of Needham informed the Alumni Association of his death. He is survived by his widow, Mildred, of 865 Central Ave., Needham. At this writing we have no other particulars.

We hope the new year brings you health and happiness.—**W. O. Langille,** Secretary, P.O. Box 144, Gladstone, N.J. 07934; (201) 234-0690

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Thoughtful news from Florence and **Lee Thomas** advises that they are giving up their Bryn Mawr apartment and moving to Allegro 90, 4031 Gulf Shore Blvd. N., Naples, FL 33940. In March this past year the couple made an air trip around the world. For the benefit of other old timers, Lee reports that during this trip he encountered a violent determatological explosion caused by a reaction to a medication that he had been taking for over 20 years. He recovered quickly I am happy to say. The Thomases expect to return to Philadelphia several times a year.

A newsletter from the Leominster Historical Society is quoted as follows. "We are eternally grateful to **Frank Maconi** because of his great gift of prudent management. Frank directed the largest and most successful financial drive during the entire 80 years existence of our society. He established a new education fund for the benefit of members and especially for our children. While retired, Frank keeps busy as director and finance chairman of the Nancy Patch Retirement House in Leominster.

A note from **Elbridge Wason** refers to his father, Leonard C. Wason, '91, who entered his twin sons Alfred and Elbridge. Alfred passed away in 1983. Elbridge points out that there has now been a member of the Wason family connected with M.I.T. for almost 100 years. A record to be proud of. We congratulate you, Elbridge.

The Society of Fire Protection Engineers (SFPE) published a picture of **Perk Bugbee** who holds

the SFPE Membership Certificate No. 1 and is known to the world as "Mr. Fire Protection." The meeting was held to congratulate the the five-year-old winner of the National Fire Protection Association's National Fire Safety Contest, Laura Cook of Fruitland, Fla., whose entry was selected from thousands.

As I may have mentioned previously, **Al Fraser** was justly cited as a prominent contributor to Wellesley's welfare. Al took over one of the town's leading florist businesses three years after graduating from M.I.T. An article in the town paper says, "Just as Fraser's flowers are recognized for beautifying the homes and brightening the lives of many people in the town, so is Alfred Fraser recognized for his contributions to the development of Wellesley's business community."

Word has been received of the death of Dr. **Clarence H. Sorum** on January 10, 1986. He resided at 938 University Bay, Madison, Wis.

As we go to press it is a pleasure to quote from a letter by Hannah Kahn, who lived with her husband, Harry, for many years in Uxbridge, Mass. Hannah writes, "I am disposing of my big home and moving to a small home in Thousand Palms, which is adjacent to Palm Springs, Calif. I expect to be visiting in the East from time to time, and if there is a meeting of the Cardinal and Gray Society, I shall make an effort to attend." Says Hannah, "I have many fond memories of M.I.T.—attending that wonderful Mid Century Convocation and all the class reunions and Alumni Days with my husband."—**Harold Bugbee,** Secretary, Apt. 313, Country Club Heights, Woburn, MA 01801

21

I had a phone call from **Robert F. Miller** late in September telling me of an accident he had on September 4 when he had a blackout for a few seconds while driving his car and ran into a steel post. I thought he might not want this printed in class notes but he said, "On the contrary, I think other classmates might like to have a warning that this might happen to them." Bob's car was totally destroyed, and he has decided he will never drive again. He had a similar blackout five years ago. Bob had black and blue spots all over his chest, but x-rays showed no broken bones. His seat companion had numerous broken ribs. Both were wearing seat belts. They were driving in city traffic in the Washington suburbs. He now walks with a cane when outdoors and still has some chest pains. A housekeeper comes in every day, gets his noon and evening meals, and does the necessary shopping. One of his daughters comes over to take him out for any necessary driving.

A clipping from the Brielle, N.J. *Coast Star* tells all about the local celebration in tribute to the centennial of the Statue of Liberty. There were bands, a parade, essays, a presentation of medals and other prize awards, ending with community singing, and the release of hundreds of balloons. The program committee included our class president, **Carole A. Clarke,** borough historian.

A letter dated September 7, 1986, from Elise Pennypacker of Stamford, Conn., reports the death of her father, **John W. Shepard**, on August 10, 1986. She said, "Dad had lived with me for the past ten years. He had worked for the Walworth Co. of South Boston. Since retiring he spent his summers on Cape Cod." Our sympathy goes out to his family.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 11203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22 65th Reunion

Parke Appel received a long interesting letter from **Jack Starkweather** who with Ellen, his wife of 60 years, is now living in Orinda, Calif. Those of us who knew Jack may recall the serious motorcycle accident in Newton that put him in the hospital for three months. Parke and Jack first met when they were the respective managers of football for Somerville and Newton. . . . **Martha Eiseman Munzer**'s personal collection of quotations (from Marcus Aurelius to E.B. White) entitled *The Three R's of Ecology (Response - Relationship - Responsibility to Nature)* has recently been published through the cooperation of the Conservation Education Association and the Department of Environmental Education of Florida's Lee County Schools in Ft. Myers.

Robert Hallock

A number of well known classmates have left us. **Robert Lay Hallock**, 88, Course II, died September 2, 1986, in the Massachusetts General Hospital after a brief illness. Hallock, living in Needham, Mass., at the time of his death, was a successful professional inventor. Among his inventions were the lever-handled ice cube tray, the disposable vacuum cleaner bag, and many special purpose fasteners. He was the author of a book on the subject of inventing. For many years he lived in Larchmont, N.Y., then retired to Boca Raton, Fla., and finally settled in Needham. He was a native of Columbus, Ohio, a World War I veteran and at M.I.T. a member of Theta Chi fraternity. Hallock is survived by his wife, Marjenette, two sons, Robert L. Jr. of Larchmont and Peter of Swansea, Mass., a brother, a sister, and three granddaughters.

Broderick Haskell, 87, Course X, died September 1, 1986, at Miller Memorial Community in Meriden, Conn. Brod had been in declining health for some time. The 1961 *Alumni Register* shows him to have been with the International Finance Co. in Washington, and the 1967 register lists him as vice-president, Bache & Co. in New York. At the 'Tute, Brod was very active: Walker Club, Beaver Club, Masque, chairman of Senior Class Entertainment Committee, vice-president of Technology Athletic Club, assistant general manager of Tech Show, and a member of the Executive Committee Inter-collegiate Conference. His fraternity was Phi Gamma Delta.

Arthur Slepian, Course VI, died May 22, 1986, in Bridgeport, Conn. I have no other information as to his family or his career. . . . **Julian Bonsall McFarland**, 86, Course X, died July 9, 1986, at Menlo Park, Calif. Mac, a member of Beta Theta Pi, retired from a position in the steel industry in Alabama to live in Sebastopol, Calif., over 20 years ago. I have no knowledge of his surviving family. Over the years I wrote to him several times but my letters were unanswered. If any classmate can supply any information about McFarland and his family, it would be appreciated. Our condolences are extended to the families of these deceased classmates.

Let's all be on hand for our 65th at Cambridge in June.—**Yardley Chittick**, Secretary, Rte. 1, Box 390, Ossipee, NH 03864

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Royal Sterling has been working on plans for our 65th reunion in June 1988. Rooms have been reserved at the Embassy Suites up the river from the Institute. Cocktails and dinner will be on Wednesday, June 1, at the M.I.T. Museum. Arrangements may be made for a sightseeing tour on Thursday. The choices are the north shore with lunch at Hawthorne-by-the-Sea, Lexington and Concord with lunch at the Colonial Inn, and lunch at a restaurant in South Boston on the harbor. Please tell Royal which you prefer (9960 A1A So., Apt. 303, Jensen Beach, FL 33457).

Al Pyle is enjoying Expo '86 in Vancouver. . . . Your secretary/treasurer had a second cataract operation which apparently came out well. The sight in both eyes now is considerably improved. . . . On June 25, **Cecil Green** was awarded an honorary Sc.D. by Green College, Oxford, which he and his wife founded.

Malcolm Carey died on July 1, 1986. He graduated with our class in mining engineering. Upon graduation he became employed by the Aluminum Co. of America and continued that association until 1965, when he retired formally but remained for five more years as a part-time consultant. His hobbies were walking, swimming, boating, carpentry, and cabinet making. . . . **Joseph Chaffee** died on February 25, 1986. He graduated with our class in electrical engineering. We have no information about his subsequent career.

Charles Mongan died on July 4, 1986. He graduated with our class in electrochemical engineering and went on to earn his S.M. degree. In 1925 he enrolled in the Technische Hochschule in Zurich where he earned his Sc.D. Working out of Draper Laboratory in Cambridge, he and his colleagues recently culminated a 10-year effort for the Department of the Interior with a major breakthrough in technical surveys for aerial photography. He worked as a consultant for several engineering firms. He was founder and served twice as president of the Boston Chapter of Friends of Switzerland. For his work with the organization and his accomplishments in the field, he received the Stratton Award, named for former M.I.T. president, Julius A. Stratton '23.

George Nesbitt died on February 26, 1986. He transferred to the Institute from Johns Hopkins University and graduated with our class in business and engineering administration. After graduation he joined Union Carbide and became superintendent of the Prest-O-Lite plant, then left for the West Coast to engage in real estate, agriculture, insurance, and banking. During World War II, he worked for the Office of War Information in California. He then returned to the East Coast to join the Mutual Fire Insurance Co. of Montgomery County, Md. In 1964 he became the president of the First National Bank of Sandy Spring, Md., which later merged with another bank to become the Sandy Spring National Bank and Savings Institution, of which he was chairman until his retirement in 1978. He served in the Montgomery County Council for four years, during one of which he was president. He was a member of the Society of Friends. He enjoyed traveling in the Western mountains and along the New England coast.

Norman Weiss died sometime last June. He graduated with our class in mining engineering and metallurgy. He worked for 43 years for the American Smelting and Refining Co. in various capacities and locations and retired in 1967 to work for ten years as a consultant. In 1975 he was elected an honorary member of the American Institute of Mining and Metallurgical Engineers. The Institute cited him for his contributions to the industry, for his services as editor-in-chief of the *Mineral Processing Handbook* on which he worked about 15 years until its publication about a year ago. He received the Robert H. Richards Award for achievement in the field of minerals beneficiation. He enjoyed golf, bridge, and his hi-fi record player.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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We have received a note from Kathy, daughter of **Joseph T. Lusignan**, that he passed away July 20,

1986, in California, we believe. We know that he lived in Delray Beach, Fla. in 1974. He prepared for three years at the U.S. Naval Academy. Joe gained an S.B. and S.M. in the cooperative electrical engineering course. After a year at Pittsfield in the high voltage laboratory, he spent two years earning a Ph.D. in electrical engineering at Stanford University. He returned to Pittsfield for two more years and moved to Ohio Brass in 1930, becoming a senior vice-president and director. He retired in 1970. He wrote a number of articles for electrical journals.

Word from his son, Dr. Gough C. Reinhardt, informs us that Col. **George C. "Scoop" Reinhardt** died in July 1986 in Santa Barbara, Calif. He was honored by military services at Arlington National Cemetery. George prepared at the Army and Navy Preparatory School, earning an S.B. in mining and metallurgy. He spent 30 years in the U.S. Army, part of it in the Iceland Base Command and 15 years as resident engineer for the Rand Corp., Santa Monica, Calif. He wrote three books on military science. Scoop was very active at the Institute—on the track team for three years and a member of Tau Beta Pi, Pi Delta Epsilon, Papyrus, Stylus, Mining and Chemical Societies, *The Tech*, and *Technique*.

William E. Delehanty died July 7, 1986, in New York City. He was one of the few classmates who graduated in architectural engineering. He was resident engineer for U.S. Engineers at the Military Academy, West Point for a while but devoted his entire career to architecture, ending as a partner in Chapman, Evans & Delehanty, New York City. Bill was a treasured friend of Marymount Manhattan College for his help, guidance, architectural knowledge, and expertise. He was an avid baseball buff, playing four years in Interclass Baseball, managing and coaching for two years. Memberships included the architectural society, Triglyph, Frieze & Cornice, T.C.A., Intramural, and other committees.

Gordon W. Harvey was commemorated by a three-foot square bronze plaque at the June rededication of the G.W. Harvey Swim Pool Complex at the Letchworth State Park, New York. Gordon was the chief engineer and general manager for the Genesee State Park Commission for 33 years, and the complex stands as an example of his architectural design and construction skills.—**Russ Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146, (617) 232-0634

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Sam Spiker writes that he and Elinor attended his 65th reunion last June at the Hill School, Pottstown, Pa. After the reunion they drove west to Holidaysburg, Pa., to see his classmate and fraternity brother **Bruno Roetheli**. As a Radcliffe graduate Elinor was a representative of her class at the 350th anniversary celebration at Harvard. After spending September 3-7 in Cambridge the Spikers went to Nantucket for several days to rest and see old friends.

A letter from **Fred Greer** informs us that he has moved to Naples, Fla. His new winter home, November 1 - June 1, is at the High Point Country Club in South Naples. His summer home is in Country Club Heights in Woburn, Mass. In mid-September Fred and Eleanor visited a granddaughter in Duxbury and then traveled on to Hyannis. Evelyn and I met them there and we had lunch together and spent a couple of pleasant hours catching up on news about our families. The Greers celebrated their 61st wedding anniversary on July 18, 1986.

It is with sorrow that the passing of two classmates must be reported. **John Cornwall** died on June 4, 1986, at Midland, Texas. **Willard C. Asbury** died at Westfield, N.J., on April 29, 1986. Bill worked as a research assistant in the research laboratory of applied chemistry at M.I.T. after graduation. In 1927 he went with the Standard Oil Development Co. and advanced to become executive vice-president of the Esso Research and Engineering Co. He served in a liaison position with that company in Germany, France and England before and after World War II.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

27 60th Reunion

Our 60th reunion is in June 1987. Every one in our class with known addresses should have received the letter from chairman **Nathan Cohn** last October. The schedule of events has been carefully arranged for an enjoyable three days at M.I.T. Opportunities to catch a glimpse of the research labs and vibrant life at M.I.T., the beauty of Marblehead Harbor, the spectacular skyline of Boston over the Charles River—these are memborable scenes to accompany our friendships, old and new, with our fellow octogenarians.

Our "motif" is **Harold Edgerton**'s "crown of a milk drop" strobe photo and he will entertain us at our reunion banquet. Send in your acceptance form and join our crowning celebration of surviving 60 years.

We are proud to report that "Doc" Edgerton has won another award. He was inducted into the National Inventors Hall of Fame for his invention of ultra high-speed photography. The patent cited in the award was "Stroboscope" issued on August 16, 1949. The Inventors Hall of Fame was established in 1973 by the U.S. Dept. of Commerce to honor individuals who have made great contributions to the nation's welfare through patented inventions that have advanced the nation's technology. Thomas Edison was the first member (posthumously) and since then 63 more inventors.

We regret the delay of the Alumni Office in reporting the death of **Abraham Mankowich** on January 19, 1983, in Bel Air, Md. He was a retired Lieutenant Colonel in the U.S. Army Ordnance. He had a distinguished career as a chemical engineer in research and development of chromium plating, metallurgy, and analytical procedures for quality control, mostly in applications to naval torpedoes. He held ten patents and presented 100 papers in these fields. After retirement from the U.S. Army Reserve, he taught calculus and drafting and was head coach for cross country at his local high school. From 1965-76 Abe was a German translater for the chemical abstracts service of the American Chemical Society.

Thomas H. Darnell died on June 10, 1986, in Memphis, Tenn. He had been a professor of mechanical engineering at Christian Brothers College in Memphis for many years. He was past president of Hancock House and retired president of Rite-Way Products Co., both of Memphis.

Donald A. Sherman died on July 10, 1986, in Medford, N.J. In 1967 he was manager of industrial sales for Suburban Propane Gas Co. and was retired in 1984. He was a member of the Sons of the American Revolution and a life member of the National Society of Professional Engineers.

We extend our sympathy to the widows and families of these classmates.—**Joseph C. Burley**, Secretary, RFD #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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Jim Donovan is back home after two trips to the hospital—once for a bout with pneumonia, then for some corrective throat surgery. It is always Jim who is quick to send a cheery note when any of us must become a patient. We can't match the Donovan style but we have sent Jim our sincere and very best wishes for a speedy return to good health.

Our August/September Notes carried an appeal on behalf of **Paul Ruch** for a replacement copy of the '28 *Technique* lost when he last moved. We are pleased to report that there were three responses and we trust that one of them will supply his need. Now and then a class secretary has the warm feeling that maybe he has been useful. So it was in the foregoing case and so it was when **Walter Hildick** was supplied with a correct address for **Jack Rouleau**. Walter says that he and Anne are about the same as always but perhaps just a bit slower in some respects. As for Jack—he should write and tell us what is new with him.

It was a delightful surprise when we had a telephone call from **Chuck Carter** in Montreal, Canada. Like many of us, Chuck had been only thinking of writing his memoirs but was inspired by the report of **Bill Hurst**'s positive action in the matter. Now Chuck believes he will really get on with it. Our conversation disclosed that Chuck, **Ken Maccart**, **Romeo Bossi** and **Walter Smith** all spent their teenage years in the same Upham's Corner area of Dorchester, Mass. Chuck prepared for M.I.T. at Boston English High School while the rest of the group attended the old Mechanic Arts High School in Boston. (Both Bossi and Maccart are now deceased). Chuck appears to be in good health but wife Phyllis is hospitalized. They had two children, a son and a daughter. The daughter has died but their son Stephen has provided them with two granddaughters.

A note from **George Palo** brings forth the complaint that for him technology has gone to the point where he cannot understand even the summaries given in meeting notices! How we do sympathize!

Florence and I have just returned from a wonderful 12 days vacation steamboating down the Ohio and Mississippi Rivers from Cincinnati, Ohio, to New Orleans, Louisiana, aboard the paddlewheeler, *Mississippi Queen*. We made all the tourist stops along the way then spent two days in New Orleans before flying home. We can recommend the cruise to anyone but it seems to be especially appealing to oldtimers like us.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Jerome Franks of Cincinnati, Oh. writes, "At age 82, there really isn't much that seems new businesswise. I have seen and participated in most all phases—as engineer, manager, and finally president. Socially, it seems my list of friends is rapidly shrinking-called attrition. But we are healthy and still enjoy our lives and those of our friends who are left. . . . **Joseph Green** of Coconut Creek, Fla., sent a brief note, "I have been living in Florida now for the past 12 years, which is our only home. I am a member of the M.I.T. Club of Fort Lauderdale, and we attend most of the meetings." . . . **William W. Saunders** of Naples, Fla., has sent me a sad note with a happy ending. "My wife Elinor died two years ago after 51 years of happy marriage. Had trouble adjusting, ended up with a heart attack six months later. A year later, I had a knee replacement and married my physical therapist three months ago. Between the two of us, we boast having five children and 11 grandchildren. My main reason for sending this reply is to thank you for your loyal support of many years of service to your class. You are unbelievable in your dedication. We all thank you." Besides being a classmate, Bill was a good friend from undergraduate days, was in the same course XVII (now part of Course II) as was your secretary, **Robert Pride** of N. Palm Beach, Fla., **Harold Pease** (deceased), and **Leonard C. Peskin**, Wyncote, Pa. He lists his hobbies as golf, fishing, and radio control of model sailboats.

Professor **Herman "Fritz" P. Meissner** of Winchester, Mass., writes, "I am sure that Kalidasa, who produced that marvelous poem, 'Salutation to Dawn,' printed on your greeting card, would have been astonished and gratified had he known how his 'winged words' still travel, even to the class of '29. (You perhaps remember how we read Ulysses' 'Winged Words' in freshman English. I get into the Institute frequently enough, enjoy

and envy the wriggling vitality of the youngsters rocketing through the corridors. No different than in our day, I suppose, except that Dot and I were terribly sorry to learn about your eye complications, which I can just begin to appreciate a little, having what is delicately called incipient glaucoma. However, you and I can take comfort from the compensation—what we have lost in sharpness of vision, we no doubt gained in virtue, wisdom, and beauty."

Anthony Standon of S. Kent, Conn. has just joined the club—having reached the age of 80, he is in the Octogenerians of Class of '29. His latest hobby is working on mathematical models. . . . **G.J. Guthrie** of Thermopolis, Wy., suffered a stroke in 1985 and he is under treatment in his city. . . . **Edward B. Papenfus** of Canada writes, "I am still in good health but have not moved out of British Columbia since April when my wife and I spent three weeks motoring through the southwestern U.S. We have visited Expo 86 about six times. It is a most interesting and entertaining display and is a great success. So far, the attendance stands at 14 million and is projected to reach about 20 million visitors by the time it closes in mid October."

Bill Baumrucker of Marblehead, Mass., writes, "I still have a couple of weeks to go before I reach the Octogenerian Day. I do hope and plan to make it! My tennis twice a week gets worse and worse with occasional flashes of brilliance (relative only to playing the other old codgers). . . . Dorothy David, wife of **Marshall David** (deceased) writes, "My 60th reunion is due next May, and I am working on the reunion fund. However, this will be my last year. It is very hard for me to get down to Boston. I manage to attend most of the meetings of the Cape Cod M.I.T. Club as an associate member." . . . **Vincent Jerry Gardner** of Belmont, Mass., has just joined the Octogenarians of Class of '29 by a celebration of his 80th birthday to which his son from California, with a 3-month-old grandson, his daughter and son-in-law from Arlington, Mass., with their 7-year-old son, and Ellie's daughter with her two sons attended. He writes, "I am hoping for a meeting of the local reunion committee to have a preliminary discussion concerning our 60th reunion in 1989."

A note from **Hyman J. Fine** of Norfolk, Va., reads, "I am still working in the office three days a week on existing and proposed water resources development projects. I am still playing tennis two and three times a week—doubles! Whatever free time is left is given to volunteer work such as auditing for the United Way, serving on the Adult Task Force, delivering Meals-on-Wheels, and participating in a weekly current events seminar. Once in a while, I am called upon to present my slides on the Mideast, which were taken on our recent trip to Israel. I wish to you and the members of the Class of '29 continued good health and happiness."

Larry Moses of Sarasota, Fla., writes, "I have just learned that I will need implants in both of my eyes soon. Kay's operation in December 1984 involved the removal of a nerve root cyst at the base of her spine. She is much better but suffers from damaged nerve pains. Fortunately, it was not cancerous. I had several blackouts in March 1986. The V.A. Medical Center in Durham, N.C., found low red blood cell production, probably medication I have been taking for my amyloidosis (liver disease) for the past four years. The medication has been changed with excellent results. After many blood transfusions from December to May, I have now gone two months with normal blood count. A sudden hernia attack put me in a local hospital for 18 days in May here in Sarasota. I am much improved now from both problems, and we both hope that the worst is behind us. We enjoyed a week's cruise in early March to the Caribbean, taking our son Bill and his lovely wife Mary. It was their first cruise, and we all enjoyed it thoroughly. This past week our daughter, Kathy Harris, paid us a four-day visit with our grandson, Jon Harris IV, a 22-month-old and lively bundle of energy."

John Happel of Hastings on Hudson, N.Y., writes, "Our trip to Europe was busy and pleasant. We had a return visit from the French scientists. I regret not having learned more French while they were here. Unfortunately, they were anxious to learn English. I finally finished my third book over the summer, and it will be published this fall. As my wife says, I am pleased to have three children and write three books because "all good things come in threes." There is nothing left but adding three square meals a day. Best wishes and good health to you, Helen, and all our classmates from Dottie and me."

I am very grateful for having so many good friends in our class who have shown their concern about my accident and the resulting eye problem. I certainly can count my blessings and say thank you to all of you. You will be interested to know that, out of approximately 750 members of the graduating class of 1929, 250 of us have survived to date. Just imagine, two out of three of us have passed on. Average age of the remaining roster of our class is 79-80. Youngest age bracket is 77, of which there are three surviving members. The youngest is **Laurence R. ("Larry") Moses** of Sarasota, Fla., born January 10, 1909. The first runner-up is **Kenneth D. Beardsley** of Dalton, Mass., born on July 18, 1909, and second runner-up is **Samuel J. Levine** of Swampscott, Mass., born September 12, 1909. The oldest member of our surviving members is **Humayak K. Asbed**, Clayton, Md., born October 1, 1895.

I regret to report the deaths of the following members of our class: **Donald R. Funk** of Cherry Hill, N.J., January 14, 1986; **Henry J. Herrel** of Bangor, Maine, July 2, 1986; and **Gerald F. Palmer** of Lafayette, Calif., July 25, 1986. Jerry was active in our class activities and participated in some of the early reunion committees. He was a native of New Jersey but was a resident of Lafayette, Calif. for 27 years, having been employed by Kaiser Aluminum Co. for 25 years. He was a member of the Kaiser Employees Association, Sons in Retirement, and the Lafayette Orinda Presbyterian Church. Jerry's son was the late Richard S. Palmer. He is survived by his wife Nelle of Lafayette, two sons, and three grandchildren.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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It isn't often that the secretary of a class that left M.I.T. more than half a century ago gets to report a classmate's marriage, but this month it happened. Last July 24, **Ralph Appleton** and Beulah Marvin were married in Columbus, Ohio. Ralph and his new wife plan to spend their summers at a cottage on Lake Walloon in Petosky, Mich., and their winters in Columbus. Based on Ralph's recent and earlier communications it appears that as a result of their merger, he and Beulah have a total of two sons, four daughters and eight grandchildren. Ralph retired about 20 years ago as president of the Good Realty Co. in Columbus and thereafter did considerable traveling, a practice that he and Beulah plan to continue. Having myself now completed seven happy years of a second marriage, I wish the newlyweds well. . . . **Leonard Goodhue** retired from the Dewey and Almy Chemical Division of W.R. Grace and Co. some years ago. He now lives alone in Winchester, Mass., and apparently his mobility is restricted to some extent by health problems. His "family" includes five nieces and nephews and their children and grandchildren. He says that "keeping house alone takes what energy I have." . . . From Omaha, Neb., **John Hanley** writes that he retired in 1973 as vice-president of Northern Natural Gas Co., now Enron Corp. He has done a certain amount of consulting work since his retirement. Other retirement activities include trout fishing, horseback riding, and golf. . . . **Willard Selden** is a retired professional engineer who spent the last 21 years of his working career in government service, including 17 years in quality assurance engineering work at the Springfield (Mass.) Armory. When the Armory closed in 1968, he transferred to Westover A.F.B. as a civil engineer in charge of pavement design until his retirement in 1972. He now spends his time on church-related activities and Rescue Mission work. He was a founder of the Springfield Rescue Mission in 1951, but retired last spring "after 35 years of 'rescuing skid-row' types, many of whom have been restored to fruitful Christian lives." . . . We have received notices concerning the deaths of two more of our classmates: **Ernie Reisner** on May 11, 1986, and **Bill Wye** on August 17, 1986. Ernie's career was largely spent as a government employee. During World War II, he served in the Navy at the old Bureau of Aeronautics in Washington and at war's end became a Naval Reserve commander. He continued as a civilian employee of the Naval Ordnance Laboratory until 1950, then transferred to the Commerce Department and in due course to the Small Business Administration. At the time of his retirement he was chief of the Industrial Support Services Division of S.B.A., engaged in evaluating the qualifications of small firms for government contracts. Ernie died of Parkinson's disease after spending several years in a nursing home in Arlington, Va. He is survived by his wife, the former Barbara Waters of Fairfax. . . . **Bill Wye**, like Ernie Reisner, was a longtime government employee. He spent 39 years as a U.S. patent examiner, examining patent applications in the field of refrigeration. (According to my records, of the five classmates who went into the Patent Office, only one, **Jim Keely**, is still living.) As many of you know, Bill was an enthusiastic "re-uner"; there were very few reunions that he missed. After his retirement in 1976, he returned to South Boston, where he was born, and he kept a summer home in Falmouth, where he was living at the time of his death. His retirement activities included dealing in commodities futures and writing poetry in the Japanese haiku style. He is survived by three brothers and a sister.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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Not much good news to report. Your vice-president **Ben Steverman**, enclosed a copy of a letter from Minna Landsman which read: "I wish to report the sudden death of my husband **Harry Landsman** on Jan. 2, 1986. I am sending a contribution to M.I.T. and wish to be kept on the mailing list." Ben noted that "Harry was a good and faithful member of our class and he and Minna added much to our reunions. We missed them at the 55th. Sorry to hear about your accident after the reunion and I hope all is well again with you and Helen. We've enjoyed an active and happy summer." (Helen and I have just about recovered from the accident. The car was a complete wreck but, thank goodness, we survived.)

Randy Binner wrote: "We thought that the reunion went very well despite the rain, or because of the rain. I had expected a larger attendance from the list of people who originally indicated interest in the affair. There were several I expected to see after a long time but they did not show. Our party arrived safely in Boston in record time due to little traffic (the rain). The **Fitzgeralds** and we got off at South Station. The old station is gone replaced by a hole in the ground and some temporary walkways and waiting room. Apparently a very large building will occupy the space. We stayed at a new hotel, the Bostonian, in the Faneuil Hall market area. Very nice. There was a great deal of activity, people running around and autos blowing their horns. The Boston Celtics had just won the basketball championship and everyone was celebrating."

A note from **Edward J. Norris**, dated April 22, 1986, reported the death of Colonel **Elmer E. Barnes**, Corps of Engineers, U.S.A. Retired on January 8, 1986: adding that Colonel Barnes was

professor, military science and tactics at the M.I.T. R.O.T.C. program. He was a graduate of Brown University and the United States Military Academy. During World War II, he served in the European theater. At the time of his death, he lived in Salem, Oregon. Burial was in Arlington Cemetary. Last but not least, the Alumni Association reported the death of **Otto Kohler** on June 12, 1986. His home address was 68 Woodbridge St., South Hadley, MA 01075. He is survived by his widow, Marion Kohler. Our sincere sympathy to the survivors.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

32 55th Reunion

The 55th reunion committee held its first meeting at the M.I.T. Faculty Club on Monday, September 22. The following classmates attended: **John Finnerty, Don Brookfield, Al O'Neil, Joe French, Robert Minot, William Pearce, Tom Weston, Wendell Bearce, Melvin Castleman, John Brown,** and Eliza Dame, representing the Alumni Association. William Pearce was elected reunion chairman as he will be able to work closely with **Don Brookfield.** It was agreed that the weekend should be as interesting as possible, centered on the M.I.T. campus, and at a reasonable cost. Many plans were enthusiastically discussed, and you will hear about them very soon.

Don Brookfield recently returned from Portland, Ore., where his youngest daughter had her first child. Don and Phyllis now have 12 grandchildren. Can anyone top this? . . . Maxine and **Wendall Bearce** have returned from a trip that included Alaska, Expo 86 in Vancouver, and the Butchard Gardens. For four weeks they traveled by air, bus, boat, and auto. They have six great-grandchildren. Can anyone top this?

Joseph L. Friedman writes us a most interesting letter. First, he comments on his birthday, July 31, 1912. Does this make him the youngest in our class? He takes on occasional management consulting assignments but also goes on several trips a year. He snorkled in the Caribbean off the Dominican Republic. He and his wife are getting very good at underwater photography. In May they were in the environs of Tahiti. They spent some time in the Yucatan Peninsula. Flying on United Airlines Silverwings Plus Program is an economical way to get around. They are now planning a Fiji trip in the South Pacific. They both had bouts with cancer that they hope are under control now. Joseph has never been back to M.I.T. since leaving and doubts whether he would recognize the place. That is true! M.I.T. and Boston have changed a great deal. Why not plan a trip in June and be at our 55th? You'll enjoy it!

We heard from **Ed Nealand**'s wife—now Eleanor Nealand Wrigley. She found some of Ed's grandfather's paper money and coins and asked for **Eric Newman**'s address, as he is an authority on such matters. She adds that she is now the wife of another M.I.T. man (S.M.'37). "Bless you M.I.T. boys, you are the greatest!" she writes.

We have received news that **Henry E. Worcester, Jr.** died in April after a long battle with leukemia. He owned and operated Morningside Laundry and Dry Cleaning Co. for 44 years. He was active in many business organizations, banks, and civic enterprises. He was also an active sportsman, especially horses and yachts. He was instrumental in the establishment of the first Unitarian Church in Annapolis, Md. He leaves his wife Margaret, four children and ten grandchildren.

We also received information that **Frederic Alexander, Jr.** died on June 28, 1986, in Rocky Mount, N.C. He was in charge of all Brewster Technical publications. He then joined Columbia Aircraft as engineering service manager. After retiring in 1969, he wrote the history of their laboratory.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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We are glad our tuition-paying days are about over. Currently M.I.T.'s tuition, room and board for one year is $16,150. The increase is partially covered by an increase in scholarship funds. That's where part of our alumni gifts go each year.

Surely you have seen the news reports of defaults on national direct student loans. The average in 1982 (the last figure available) was 10.4 percent, while the M.I.T. loan rate was 2.69 percent. Defaults on loans made directly to students by M.I.T. was only 1.8 percent. Not only did we get a good education, but we also came through with a good sense of responsibility.

Dayton Clewell has moved from Darien, Conn. to Pasadena, Calif., to be near his daughter Nancy and her family. His son lives in Ann Arbor, Mich., where he is a member of the medical school faculty.

William C. Hinckley of Course I passed away last summer. He had been with Pan American Airlines for many years. . . . **Gardner W. Hicks**, a retired civil engineer with the army, also died last summer.

Bill Pleasants, who has worked with seashore cottage sewage disposal, writes to say he is now representing the Delaware Society of Engineers on a Legislative Advisory Committee on septic tanks. Our experience and training is desperately needed to help householders and taxpayers fight for their rights against overpowering bureaucracy. His advice to us: "Get involved!" If you want his address, drop me a note. He is engaged in restoring an old house where wooden sailing vessels were once built. His letter makes it sound like fun.

Bill Gray living in Charlottesville, Va., home of the University, writes that to reduce his electrical engineering load he resigned from Palisades Institute in New York City and is now a full-time horticulturist. Is he the only Course VI graduate on intimate terms with microflora, etymology, and soil chemistry? He says he may be the only farmer in the Southeast reporting a profit to the IRS. Good for Bill.—**Beaumert Whitton**, Secretary, 5150 Sharon Rd., Charlotte, NC 28210, (704) 553-0515

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This month we have a few contributions, but Bob's and my (**George Bull**) travels will fill up some space. Please make it possible in future months for Bob and I to have little chance to talk about ourselves.

Information supplementing Bob's recently excellent notes on **Ken Ryder**'s death tells us that the event occurred July 3, 1986. . . . **Albert G. Kern, Jr.** passed away June 19, 1986. He came from an old Knoxville, Tenn., family, where his father established a commercial bakery. After Tech, Albert worked as an engineer for TVA, until he resigned 40 years ago to take over the family-owned stock farm. He was active in many civic projects and president or on the board of organizations such as the Knoxville Civitan, Sons of the Revolution, and his Presbyterian Church. He is survived by his wife, son, daughter, and grandson.

Mary Elizabeth and I had an interesting and disappointing cruise last winter to the Southern Hemisphere in the hope of seeing a spectacular Halley's Comet. The trip was interesting because of the lecturers we had such as Scott Carpenter, the astronaut, and Walter Sullivan, science writer for the *New York Times*. We visited the radio-astronomy dish at Arecibo and some Brazilian ports including Rio and the Amazon Delta. The comet to the naked eye looked like a small distant ball of yarn that was unravelling. You could only see the tail with the aid of your seven-power field glasses. It looked as if it was about two inches long.

To John F. Taplin, '35, the Bronze Beaver, the highest award for alumni service to M.I.T., for "his continuous service to the Institute, his outstanding leadership for his class, and his capacity to inspire his fellow alumni. . . . M.I.T. has been one of his abiding concerns throughout his lifetime," says the citation.

Bob Franklin writes, "My trip to Scotland and England was pleasant. The weather was reasonably cooperative—at least it did not rain. The first ten days in Scotland was with a Quarter Century Club group. It was primarily in the north of Scotland and included a visit to Inverness to see the semi-tropical gardens on the West Coast, courtesy of the Gulf Stream. We were also in Oban and had a day's trip to the islands of Mull and Iona. On the latter there has been a religious community since the 900s. After that I went to London, got a car, and drove as far north as York, visiting a dozen of the Great Houses, some new and some a pleasant return. Finally I was able to see friends in several places in the south of England."—**George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815; **Robert M. Franklin**, Secretary, Box 1147, Brewster, MA 02631

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A welcome letter from **Alexander Frank** at Key West: "The 50 years out of Boston and M.I.T. got to me. After attending the reunion I found my four fraternity brothers addresses and this past August we had our own reunion. We celebrated **Arthur Greenblatt**'s 75th birthday in Lambertville, N.J. Present were **Edwin Kuss** who started with us in the Class of '35, but dropped back into '36 with a course change; **Fred Krause** and Norman Krim, '34. The only one missing of our original four from Phi Beta Delta was **Sam Sealeman**. If anyone knows where Sam is I'd love to find him. I've been retired in Key West for ten years." Alexander's complete address is 1420 Von-Phister St., Key West, FL 33040.

We haven't had an epistle from **Bud Pflanz** since before our 50th; here's the latest: "As announced during our 50th dinner at Wiano, Gloria and I got married on September 14, 1985, here in Sierra Vista, Ariz. Two long-time friends flew out from New Jersey to attend the wedding. Gloria is finally becoming acclimated to this loafing life but she misses the bustle of the large city. Instead of theatres, large movie houses, night-clubs, discos, etc. we attend rodeos, county fairs, Art-in-the-Park exhibits, wine tastings (Arizona wines) and Mexican fiestas to mention a few of our activities. This October we are taking a trip back to damp, dank, dreary New Jersey for a two-week stay. T'will be a distinct contrast to our visit in July to Lake Havasu City, home of the London Bridge, with the temperatures at 110 degrees F. Marvel of all marvels was the lack of bitey bugs, no gnats, flies, mosquitos so I could go swimming after sun-down. When I think back to my war-time tour in India being bitten over and over again—ugh.

"Our summer monsoons are over and once again our afternoon skies are true blue. However, the desert is alive with new color and growth. The so-called "grass" literally grows inches over night, not to mention critters large and small—

crawling, hopping and flying. Oh well. A martini (no olives, they are fattening) or two at sundown inspires one to be at peace with nature. Regards." Thanks for writing, Bud, and I can guess the time of day you were writing!

Prexy Bernie Nelson wrote: "Thought it about time I wrote something for our class news. As always Rhoda and I have been busy with our house full of family starting in June and ending in August. The grandchildren enjoyed swimming in Nantucket Sound and then to the lake in front of our house. The house now seems quite quiet and I am trying to get back to some jobs around the house. To get away from the Cape we took a drive to Nags Head, Hatteras, Ocracoke, Beaufort, Atlantic Beach and New Bern in April which was interesting since we had not been there in years. On the way back we stopped overnight with Marj Edgar in Leesburg, Pa., and had a great visit. She is doing very well, but of course misses Eddie. In May we visited our daughter in Dallas and attended Southern Methodist graduation where she received her masters.

"Jo and Don Gittens arrived on their power boat in the middle of August and tied up at Saquatacket Harbor. They were here over a week and we had many dinners with them and reminisced about our 50th and other reunions. I gave Don the tape that **Ed Taubman** made of our 50th which he was going to show other classmates. They were leaving here for Cuttyhunk, Stonington, and back to Port Washington, N.Y.

"At the end of August Rhoda and I went to the M.I.T. Club of Cape Cod picnic at Orleans Yacht Club. Jan and **Leo Dee** were there and also **George W. Bartlett** from Osterville who had just joined our Club on the Cape. We now have eight classmates on Cape Cod.

"Now that I have taken a little over a year on sabbatical leave from class functions I plan to start writing to all class officers this fall when the weather is bad. The letters Rhoda and I have had from so many classmates about our 50th together with snapshots were appreciated. Our thanks, also thanks to all of you who helped to make the reunion a success. By now I hope I have straightened out all our finances and paid the many bills. I must report to you that we are solvent!

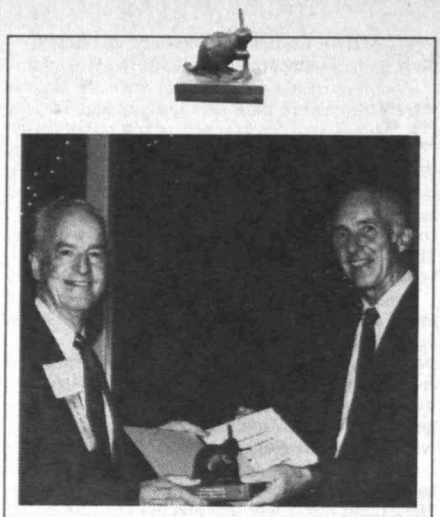
"In the Fall I will ask all our officers to express their feelings and that of classmates about a mini-reunion in March, 1986, just two years prior to our 55th in 1990 which will be June 6 to 8 at M.I.T. and June 8 to 10 at Wianno as requested at our class meeting in 1985. The dates have been confirmed with the manager at Wianno. It seems like a long way off but it will come faster than we think. The 50th was fun so let us make our 55th even greater. The attendance was excellent and the 96 percent participation in the Alumni Fund Drive set a record that will last a very long time." Please send your ideas relative to a mini-reunion to Bernie or me.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

36

I am just back from the National Alumni Conference in southern California. where our class had two distinctions: **Henry Lippitt** was awarded the Bronze Beaver, and '36 was the only class which filled a table at the banquet.

President Paul Gray cited us in the introductory remarks to his banquet speech, which was a masterful job, including his fielding of questions from the floor, a couple of which were line drives. Present to congratulate Henry were **Richard De Wolfe, Bill Mullen,** Dottie and **Tony Hittl,** Vivienne and **Eli Grossman,** and my wife Phoebe and myself.

Eli sent me a clipping from the *Hartford Courant* on the genesis of lightning which discussed at length **Bernard Vonnegut** 's air convection theory, developed in 1953, versus a hail-and-ice-crystal-collision theory. I incline to Bernie, both from my early brief exposure to lightning research and later viewing of a model at the University of Nevada. Bernie continues as professor of atmospheric science at the State University of New York, Albany.



To Henry F. Lippitt, II, '36, from Joseph G. Gavin, Jr., '41 (right), president of the Alumni Association, the Bronze Beaver, the highest award for alumni service to M.I.T. Lippitt, who has been class agent for l5 years and a loyal worker for capital fund programs, was cited as "a major force in class activities since graduation. His leadership in the Los Angeles area has done much to develop understanding of M.I.T. and to achieve more effective alumni relations."

The 50-year class gift continues to grow. At reunion it was $3,531,000 and 78.1 percent participation! Further, classmates planned future gifts which completed will add more than $2 million to the total. Chairman **Lou Stahl** credits these remarkable results to the loyalty and generosity of the Class, the diligence of all his canvassers, and his principal assistants: **Henry Johnson, Henry Lippitt,** and **Bill Rousseau**.

A proposal to the class—please let me have your thoughts. By now all of us have lived our biblical three-score-years-and-ten, and what an age it has been! Only a few years before we were born, the Wright Brothers first got off the ground. In our lifetimes, unimaginable (then) things have been developed and perfected. We have all been part of this grand design, no matter how remote our science, engineering, business, or other pursuits may have seemed. The economy which supports the great American endeavors depends on the energies and skills of all of us—in whatever field of endeavor. And our noble Institute, with our support, is at the heart of this immense progress.

So I propose that, when a classmate passes on, we each memorialize with a thanksgiving for his/her life and work, and give a toast to the memory of soul and spirit. Let's have a cheer for those who have left us, and a toast for the next one to go!

So, glory to **Walter Sylvester**, who passed away on July 19. His daughter Hope wrote that he wanted so very much to attend the 50th, and you will see his biography in the reunion volume. His honors were many, in military, corporate, and private life, and his enthusiasm for M.I.T. runneth over to his family. They are making a memorial contribution to the scholarship fund, and in the obituary suggested the fund to friends. Also, his wife Lillian (45 Hillcrest Rd., West Caldwell, NJ 07006) and daughters Joye Maloney and Hope Sylvester requested that *Technology Review* be continued through the period of 50th reunion reporting and these notes, that they might know about the occasion that Father had to miss. Bless them all.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501; (505) 988-2745; **James Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570; (914) 769-41714

37 50th Reunion

Eugene P. Cooper (8579 Prestwick Dr., La Jolla, CA 92037) is program director for research Naval Ocean Systems Center in San Diego. His hobbies are piano, swimming, amateur astronomy and classical music. His travels have been to Europe—four times, Alaska, Panama Canal and is now planning a trip to Australia and New Zealand. Wife Marjorie's main interest is mathematics. His son Philip has three children, daughter Deborah has no children, daughter Phoebe has three children, and daughter Loretto has a daughter. . . . **Philip H. Peters** (Box 362, Wellesley Hills, MA 02181) reports that his youngest son Jeffrey who was 13 at the time of our 25th reunion was unsuccessful in his recent bid for the Democratic nomination in the 5th Connecticut Congressional District. Jeffrey is an advocate of environmental and conservation issues, college assistance aid, controlling the catastrophic rising cost of medical insurance for the elderly, cutting military spending for nuclear weapons while strengthening conventional forces and tax credits only for technological research and modernization of industry. Jeffrey graduated from Harvard College in 1970 and received his masters degree from the University of the Americas in 1973. He is founder and chairman of New Democratic Dimensions Corp., a forum for bringing innovative approaches to the Democratic Party. Jeffrey says that voters of Connecticut will hear from him again.

Michael Zinchuk (145 Gosnold St., Hyannis, MA 02601) writes about the "Around the World Tour" he and Ann began on May 21, 1986. He writes, "We circled the Globe starting from Kennedy Airport, flying east and then returning via Anchorage, Alaska, to New York. We went to Helsinki and then to Moscow for an interesting, friendly and enlightening stay; to Samarkand, in the Uzbek Republic near the Afghanistan northern border, and to Tashkent, the capital of the Uzbek Republic. From a Siberian city called Irkusk, which started as a Cossack encampment and today is probably one of the greatest fur trading centers, we bussed to the deepest lake in the world, Lake Baykal; from Irkusk we started for Beijing (Peking) boarding the Trans Siberian, Mongolian, Chinese Rail Express. Traveling through Mongolia, we passed cities such as Ulanude, Goosinoe Ozera, Darkhan, Ulan Bator, Nankoy and finally Beijing. In the Gobi Desert in Mongolia, we noted wild horses and camels. Since the railroad tracks have a different gauge between China and Mongolia by several inches, at the border we were shuttled into a car barn where each car was lifted by four hydraulic jacks enabling the mechanics to exchange the wheel undercarriages, thus we were not inconvenienced and remained in our compartment. The trip to China gave us an opportunity to view the Great Wall since the route was along a good portion of it.

From Beijing we flew to Shanghai where we boarded a train for Suzhou, the Venice of China; then to Hangzhou, the Silk Capital and the City of Lakes; from Hangzhou to Hong Kong by air then to Seoul, Korea; Korean Air transported us to Anchorage, Alaska, and then to New York. We had excellent accommodations, good food, excellent tour companions and met a great many warm and friendly people. I am fortified with the fact that if you go as a friend you will be treated as a friend. Ann's time now is spent with friends, reading and music."

I regret to report the death of **Richard Surbeck**, 17 Seavers Rd., Orleans, MA 02653 in July, 1986.

By now you should have received the reunion office announcements of our 50th reunion, June 4-7, 1987, asking whether you plan to attend the presidents dinner and Boston Pops June 4th, Technology Day and Alumni luncheon June 5th, and our Wequassett Inn (Chatham) weekend June 5-8. Again we urge you to plan to join your classmates for this once in a lifetime event and return your preliminary reservation card. If you did not receive this mailing please drop me a note and I will see that one is sent to you. You will soon receive a mailing with instructions for ordering your 50th reunion crimson blazer. In addition, if you have not yet returned information for our 50th Reunion Class Book you will soon receive a second mailing. Please complete and return your questionnaire promptly. If you lose the questionnaire, please write and I'll send you a copy.—**Lester M. Klashman**, Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Mary and **Jim Barton** drove and ferried to the Olympic Peninsula, where we joined them for a delicious dinner in a restaurant overlooking the twinkling lights of Gig Harbor's sports and fishing fleets. Jim and Mary were planning air travel east to the Massachusetts fountainhead and then to the family homestead near Newport, N.H. . . . Billie and **George Cremer** visited EXPO 86 in British Columbia and didn't seem to mind "camping out" for a couple of overnights in the residence Hilda and I had occupied just the week before (at the address below).

Our new-old residence is on the west side of Puget Sound. The view to the east is through glass and over a deck. A hundred feet below is Puget Sound and its busy marine traffic. A thousand feet to the north are the three catenary-supported spans of the new Tacoma Narrows suspension bridge, which replaced the "Galloping Gertie" bridge that came to an oscillating, disastrous end in the 1940s. On the eastern shore of the Sound, we see about 12 miles of Tacoma's skyline and its lights at night. Beyond that, on clear days, we can see majestic Mt. Rainier, 60 miles away, snow-capped and towering in its 14,000-plus feet of splendor. If classmates are not able to visit and share that view and the fun, they are invited to sit down promptly—like right now—and send along news about their adventures.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., N.W., Gig Harbor, WA 98335

41

Received an interesting commentary from our peripatetic West Coast correspondent, **Robert W. Blake**: "Take a good look at the photo on pages 4-5 of the July 1986 *Review*. There are at least eight of our classmates in that photo stationed at Wright Field in 1942: **Leon Crane**, **Bill Lamar**, **Bob Williams**, **Ray Berry**, **Charlie Butt**, **Chet Hasert**, and several others whose names I cannot identify. Perhaps one of our veterans in that picture can help us out."

At the picnic of the M.I.T. Club of Cape Cod '86, I ran into **John W. Meier**, who gives this account: "Married, three children, four grandchildren. Spent four years as captain in the U.S. Army, Ordnance Dept. Homes in West Hartford and in Brewster, Mass. Worked on propellers, electron beam welding, and as chief materials engineer with Hamilton Standard. Worked later in various executive positions at Gulf and Western. My final position: executive vice-president at Knock (division of Gulf and Western) Metal Treating Co." John looked great and we relived many shared experiences of long ago.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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In the news once again was **Bill Thurston**, president and CEO of GenRad, Inc., Concord, Mass. Last summer the publication *Mass High Tech* ran a feature article describing the tribulations of GenRad in a declining market for automatic test equipment used with semiconductors and electronic circuit boards. Also described were Bill's moves to reorganize and downsize the company, reduce costs, and introduce new products. Bloody but unbowed, both Bill and GenRad survive and look hopefully to the future. Hang in there, fellows.

According to *Tech Talk*, **Virgilio Barco-Vargas**, the new president of Colombia, is not the first M.I.T. alumnus to head a nation. That distinction went to Jose Ferrer, '29, who was three times elected president of Costa Rica. Virgilio has held virtually every ministerial post in Columbia at one time or another, as well as serving as Colombia's ambassador to both Britain and the U.S. If that were not enough, he was also a member of the M.I.T. Corporation for two five-year terms, 1970-80.

Moved by my pleas for news, **Bill Voorhis** has written a long letter from Roswell, Ga., where he replanted his New Hampshire roots over two years ago. Bill and wife Ruth keep busy with crafts and fishing. Besides those, Bill has also spent some time discovering the pleasures of attending meetings of the Atlanta M.I.T. Club, and catching up on the new generation of Tech lore. It appears that class of '43 members are likely to be the senior alumni present at a club meeting, with the officers being mere striplings in their twenties, and many of them female. Coeds, he says, have changed greatly, bearing no resemblance to our old girlfriend Murgatroyd. What with one thing and another, he wonders if the Institute is a safe place for his grand-nephew, a nice, innocent Dutch boy from Vermont. Those grim, grey walls hide a multitude of surprises and delights.

I am always grateful for letters, so don't delay, write today.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Norman Beecher, adjunct associate engineering professor at Tufts University in Medford, Mass., is associated with the University's Center for Environmental Management. Last year he traveled to Denmark, Sweden, West Germany, and the Netherlands to study European methods of dealing with hazardous waste. During a panel meeting sponsored by Tufts University's Center for Environmental Management at the National Academy of Sciences Conference Center, Norm presented his findings on the methods that these countries follow to reduce hazardous waste. . . . **Lawrence J. Varnerin, Jr.**, has been named chairman of the department of computer science and electrical engineering and the Chandler-Weaver Professor at Lehigh University. Larry was formerly head of the heterojunction integrated circuit and materials department at A.T. and T. Bell Laboratories in Murray Hill, N.J. During his career in industry, he authored or co-authored 20 technical articles and received 12 patents on inventions.

We regret to report the passing of **Hilliard Roderick** on May 25, 1986, in Washington, D.C. Hilliard received his S.B. degree in course VIII at the Institute and his Ph.D. degree from Stanford University. He was a former director of the Organization for Economic Cooperation and Development, based in Paris, and was active in campaigning against nuclear war. Under his leadership, pioneer work was carried out to further international cooperation to combat acid rain and to develop codes of conduct for dealing with trans-border pollution and guidelines for testing hazardous chemicals. His research work resulted in the book "Crisis Management: Avoiding Inadvertent War," which he coedited with his wife, Ulla S. Magnusson. He recently set up the Hilliard Roderick Foundation for Prevention of Inadvertent Nuclear War. He is survived by his wife.—**Andy Corry**, Co-Secretary, Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, Co-Secretary, 53 Maugus Hill Rd., Wellesley, MA 02181

46

Where to begin? To say the 40th reunion was memorable hardly scratches the surface. Let's just say this summary is the start of a mini-series and covers only the highlights of our autumn weekend in Vermont, with many more personal stories yet to tell. This short first part is mostly because of the short turnaround between getting home from reunion and the copy deadline.

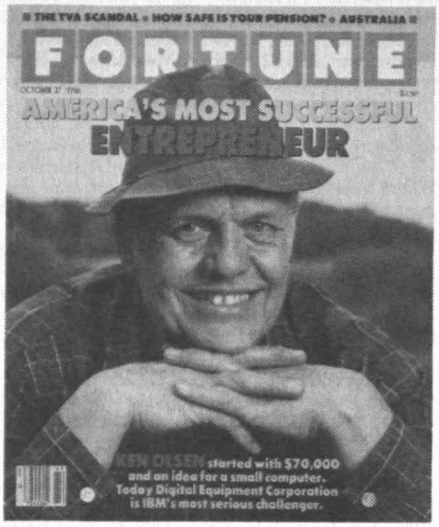
To set the scene a bit, we drive into south central Vermont, climbing some 1,500 feet to the Stratton Mountain Resort, complete with lodges, condos, lifts, golf course, and tennis courts. The prime blessing was the weather which, though iffy on Friday, came up sublimely, spicy clear on Saturday with hillsides draped with every fall color imaginable. Sunday wasn't quite so sparkling, but it was clear enough and warm enough to be quite enjoyable.

The reception Friday, September 26, was a tad dismaying to me because old roomies **Jim Corbett**, **Al Little**, and **Stan Young**, were absent, but they showed up Saturday and "closed the loop," as it were. Meanwhile, we sipped and supped with a swarm of new and old buddies amidst mounds of nummy hors d'oeuvres.

Saturday shimmered not only with Vermont brilliance, but with the pyrotechniques of our notable economist, Les Thurow, who gripped our attention with an appalling view of our nation's economy. It seems we need to get steeled for a "hard landing" after decades of heady abundance! A very revealing, sobering, yet entertaining couple of hours. After the seminar Prez **Jim Goldstein** presided over a brief meeting for business in which reunion chairman **John Gunnarson** was ushered in — per tradition — as our new class president with loud "ayes"; and **Glen Dorflinger**, who did such a heck of a job on the 40th gift committee, was similarly "ayed in" as the next reunion's committee chairman.

Our Saturday evening "main event" was accompanied by an "Oldies But Goldies" combo; beginning with a reception in the stunning Art Festival Gallery annex to the Stratton Inn, moving smoothly into the banquet room, intermixing old/new alumni friends. There was a brilliant speech by John Gunnarson, followed by a moving, touching review of our class's accomplishments by Jim Goldstein, recognizing, among many, many things, the sizable contributions of **Ernie Buckman**'s 40th gift committee (more of which will appear in our continuing series). Jim introduced **Dave Hoag** with his illumination of the results of our questionnaire relative to our sociological human condition. This is all registered in an enormous booklet assembled by **Tom Wescott** (unfortunately Tom couldn't make it) which incorporates mini-bio's of 30 percent of our class, a pretty reasonable cross section of our lives. Dave's address was followed by a marvelous show-and-tell slide presentation by **Bill Seibert** which displayed the then-and-now-extraordinary development of our beloved institute. The whole program reflected the thought and caring of John's committee which pitched-in in every imaginable, helpful way. **Jim Waters** showed us where and how to register; **Bill Cahill** handed out our red-and-gray wind breaker jackets; Lee and **Warren Turner** gave us our information packets; and so on.

We "closed the Inn" about midnight, but some 15 stalwarts greeted the dawn with a climb up the ski runs to the top of Stratton Mountain. There was also some tennis played by Phyllis and **Bud Brylawski** with Freddi and **Bill Rapoport**, and



Peter Petre in* Fortune *magazine says Kenneth Olsen's "unostentatious style has kept him from becoming a business celebrity." But he's wrong, at least in New England. When* Fortune*'s cover proclaimed Kenneth H. Olsen, '50, president of Digital Equipment Corp., to be "America's most successful entrepreneur," the magazine was a sell-out on most Boston newsstands.

another bunch with **Bob Spoerl**. Which brought us into a thoroughly delicious brunch at the Inn to finish the weekend in a rosy glow. As Bettie and I wended our way down the mountain and along the West River bordered with alders and maples and sycamores I know I heard Maggie Whiting murmuring "Moonlight in Vermont." Stay tuned for next month's episode.—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

47 40th Reunion

FORTIETH REUNION ESCAPE TO VERMONT: You should have received at least one personal communication from President **Claude Brenner** and Reunion Chairman **Bob Horowitz** containing details of our 40th reunion escape to Vermont after the Technology Day luncheon in June. If you have not, please call, write, or cable the address below for instant response. What the mailings will not tell you is that several committee members, in the guise of making arrangements, have been visiting the scene and previewing the delights as they continue their rehearsals, and they predict a fantastic performance in June.

Besides **Bob Horowitz**, the reunion committee includes **Harl Aldrich**, **Claude Brenner**, **Hugh Flomenhoft**, **Virginia Grammer**, **Don van Greenby**, **Arnold Judson**, **Alex Pastuhov**, and **Parker Symmes**. Please let us know if you plan to come to the reunion so we can let our classmates know and so that others who may wish to see you especially will be encouraged to come.

Our 40th reunion class project, the Class of '47 Professorship, is still a long way from reality. It needs every gift you can almost afford to give. Do realize that a gift to our professorship is also a gift to the larger M.I.T. core needs campaign. Your pledge now for the next five years is also desperately needed. It, too, will count toward our goal. The giving of appreciated securities has become an even better way to give, considering the changes in capital gains taxation.

Claude Brenner, indeed, ranged as far as the National Alumni Conference in Costa Mesa, Calif., in October, telling of his discoveries and encouraging classmates to attend. He enjoyed a mini-reunion there with **Arthur Schwartz**, **Martin Schwartz**, and **John Bartelt**. John, Martin, and Arthur have pledged to come to the big one in June.

Another early registrant is **John Contegni**, president and chief operating officer of Pavarini Construction, Greenwich, Conn.

Gabe Isakson, who finished a master's in aero engineering with our class, and later an Sc.D. has retired from his position as structural methods engineer with the Grumman Corp. in Bethpage, N.Y. According to rumor, he and his wife Ann are considering moving to the West Coast, where their two married sons now live.

In August **Paul Hellmuth** died in Cambridge. He was a prominent Boston lawyer, civic leader, businessman, and a managing partner in the law firm Hale & Dorr until his retirement in 1976. His fund-raising expertise benefited many organizations, including M.I.T. and the local United Way. Among the many organizations he served as trustee are the Boston Museum of Fine Arts, Harvard Law School Association, the Boys Clubs of Boston, Museum of Science, Boston Ballet, the Retina Foundation, the Children's Hospital Medical Center, Massachusetts Memorial Hospitals, the University of Notre Dame, and the New England Aquarium, where he had been president. He was a fellow of Brandeis University.

After graduation from Notre Dame University in 1940, Paul entered World War II as a private. By the war's end, he was a lieutenant colonel in the air force and had been awarded the Legion of Merit, the Bronze Star Medal, and France's Croix de Guerre. He joined Hale & Dorr after attending M.I.T. (Course XV) and with a degree from the Harvard Law School, becoming a managing partner in 1955. He leaves a sister and several nieces and nephews.

John Glendening died in Florida in May. At the time of his death, he was president of MAJN, Inc., a manufacturer in the dental field. He is survived by his children. . . . A note from Kathryn Duncan and a clipping from the *Washington Post* tell us of **William Duncan**'s death in April in Pennsylvania. He was in the navy in World War II and was recalled to active duty during the Korean conflict. He was with Westinghouse from the early 1950s until his retirement in 1984, working in Philadelphia, Washington, and Huntsville, Ala., on defense contracts and other transactions with government. He leaves his wife, four children, and seven grandchildren.

Road patterns downstream from the Longfellow (Salt and Pepper) Bridge are undergoing change. A park will replace the asphalt between the Sonesta and the river, with all traffic routed to the other side. We anticipate a walkable route from the Sonesta to M.I.T. by the mid 1990s.

Please send along the good news of your lives, even the ordinary news of what you are doing these days. We need to balance our losses, which sometimes seem, like this month, overwhelming.—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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Denny McNear, chairman of our reunion gift committee, called a meeting in October to complete the definition of goals for our 40th reunion gift campaign. The meeting was attended by **George Clifford**, **Dick Harris**, **Norm Kreisman**, **Bill Maley**, **Sonny Monosson**, **Peter Saint Germain**, **Milton Slade**, **Denny** and myself. Taking part in a telephone conference call during the meeting were **Ed Allen**, **Marshall Baker**, **Joe Bongiovanni**, **Ken Brock**, **Dan Fink**, **Tom Folger**, **Curt Green**, **Bill Hosley**, **Bob Ormiston**, **Jack Page**, and **Bob Sandman**.

The committee had a lengthy discussion of the number of dollars that we should set as a goal. It is difficult to capture in these notes the words used by the optimists in recommending big numbers, or the strained expressions of the "realists" explaining the problems of unrealistically high goals. **Norm Kreisman** resorted to some arcane scientific/financial calculations and suggested $2\pi + \Delta$ million dollars as our goal. He said this is a way to express our willingness to strive for 2π million dollars while agreeing with the optimists that we want to do more. Our class has demonstrated support for M.I.T. since the gifts received to date already exceed any previous 40th class gift. We all agreed that "The Δ is up to us."

Members of the Alumni Fund staff commented that our class had more laughs and spirit setting the $2\pi + \Delta$ goal than other classes. Those of us who also serve on 48's reunion committee explained that anyone looking for entertainment should visit a '48 reunion committee meeting.

On a serious note, Denny asked for suggestions about increasing participation. We have not made any records concerning the percentage of our classmates who support the Alumni Fund. Many of us have just accepted this. Being the largest class in the Institute's history and having so many World War II veterans who entered as freshman in various years, but finished in '48, we were not surprised at our inability to extend our class spirit to every member of the class. Our 40th reunion may be the last time we have a chance to change this. Denny wants to make this an all out effort, and **Bob Sandman**, chairman of the 40th reunion, feels the same way about attracting all classmates to attend the reunion.

Bob had two meetings of the reunion committee in the spring of 1986. Bob feels, as Denny does, that the high degree of class spirit that exists among several hundred classmates has been rewarding to everyone who is involved. It has been disturbing to miss many classmates who for whatever reason are not included. One factor in the 40th reunion Committee's decision to have the reunion based at M.I.T. was the hope that this would attract classmates that we have not seen for a long time.

As reported in an earlier column of these notes, a number of classmates wrote to Bob and asked that provision be made for keeping reunion costs to a minimum. The reunion Committee discussed the possibility of helping to arrange for out-of-town classmates to stay at the homes of classmates in the Boston area. Another possibility is to make it possible to attend and pay for only one or two events of the weekend and not be expected to attend the entire program. This approach although desirable in some ways has the limitation of how to apportion the overhead costs for the entire weekend to one event.

The reunion committee made another decision with the hope of increasing participation. They selected the October holiday weekend as the date for the reunion. June has many conflicts with family oriented events, and by changing the date to October, the committee hoped to increase attendance. For our 40th reunion, both the reunion committee and the reunion gift committee plan to work on increasing participation.

To be precise about participation is difficult, but today our class has approximately 1,000 classmates who received the Bachelor's degree sometime during 1948. At the previous Class of '48 reunions, 260 classmates attended at least one reunion. In recent years about 600 classmates supported the Alumni Fund. In addition, another 380 people received graduate degrees in 1948, and many of these alumni also contribute to the Alumni Fund.

Charlotte (nee **Potter**) **Fraser**'s response to a recent request for news for these class notes was to say that she is still in school. Charlotte has com-

pleted the course work for her Ph.D. in Education at the University of Buffalo. Progress on her thesis about academic libraries has been slow.

Charlotte has been active with the M.I.T. Club of Rochester where she works at an educational opportunity center that is part of a state university. Their program is aimed at helping people with educational disadvantages.

During her working career, Charlotte feels that she has had more than one manager who held her back and assigned her to work because "that's a woman's job." In addition to teaching science, she also had other jobs in medical and industrial research. She is an assistant professor at Niagara County Community College.

Her travels have included a white water rafting trip on the Snake River and a visit to Yellowstone National Park. She is currently considering a trip to either the Northwest Territory or snorkeling in the Virgin Islands.

She attended her 40th reunion at Bryn Mawr. Her three children are all married.

Bob Crane has been an M.D. for six years. After a quadruple coronary bypass operation while he was an intern, he finished his internship. He joined Sterling Drug as director of clinical research with worldwide projects under his guidance. He visits S. America, S. Africa, and England twice a year as part of reviewing and evaluating the efficacy of pharmaceutical products that Sterling is testing without the restrictions of the U.S. regulations.

Bob and his wife Jonnie live in Manhattan and walk to work. They don't own an auto. Recent travels included a cruise in the Caribbean and touring New England while enjoying bed and breakfast in many homes. Bob is a grandfather. Bob sent his drums to his son Kenny who was a full time jazz musician. Now Kenny is into satellite communication and only part-time in a band using electronic drums.

Mike Kami was appointed to the board of directors of Harley-Davidson, the only U.S. manufacturer of motorcycles. They also are a defense industry supplier. Mike's management consulting company specializes in management strategies. He founded the firm 20 years ago. In addition to authoring several books, Mike publishes Kami Strategic Assumptions, a quarterly newsletter.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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James M. Lydon was recently named chief operating officer at Boston Edison Co. in Boston, Mass. . . . **N.A. "Andy" Anderson** has been named vice-president of Champion International Corp. In this position he is responsible for all converting operations affiliated with DiaryPak, manufacturer of packaging for milk and juice cartons. Champion is America's leading manufacturer of paper for business communications, commercial printing, publication, and newspapers. The company owns or controls 6.5 million acres of timberlands in the U.S. and is also a major manufacturer of plywood and lumber. . . . **James Daley** was recently named vice-chairman, Connecticut National Bank, subsidiary of Hartford National Corp.

We regret to announce the death of **Richard E. Glenn** who died in January of 1981.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

51

It is a pleasure to begin my stint as class secretary by telling you the happy and successful story of our 35th reunion. It would have been enough simply to share that period with the 164 classmates there, but the weekend was punctuated by a succession of memorable events. We continued our class's pioneering tradition by being the first to use the beautiful new Wiesner Building as the site for our pre-Pops buffet dinner. Under **Harry Glenzel**'s direction, this enjoyable prelude to the traditional Pops concert set the pace for all that was to follow. On Friday, Technology Day presentations provided us with a peek into the developments in computerized screen and video animation for education, communication, and amusement purposes. The major highlight of the reunion was our very elegant banquet at the Ritz-Carlton. The arrangements made by **Tom Kelly**, **Walt Davis**, **Bill Cavanaugh** and others on the banquet committee provided the grandeur, and with **Jay Rosenfeld** as the master of ceremonies, this turned out to be everything we had been anticipating. At the banquet, we welcomed **Bill Maini** as our new class president and **Harry Glenzel** as the chair of the next reunion. This function was more than worthy of Tech's most prominent class. Carol and **Dick Reedy** graciously hosted our Saturday clambake at their beautiful home and estate in Gloucester. Having them show us through their home was a treat in itself. **Parker Hirtle** gave them much assistance. The lobsters served in the tent mixed well with the equally rich friendships we were able to renew. Someone mentioned that there was some rain during the four days, but we were too tied up in the enjoyment of the events to notice. The Sunday breakup brunch arranged by **Hank Spaulding** was the final touch of this most memorable of reunions. We are all indebted to reunion chair **Ken Kruger**, who had to spend countless hours away from the joys of his new-found (since last reunion) fatherhood. **Bill Maini**, **Chuck Hieken**, **Marty Murphy**, and **Jerry Marcus** provided Ken with valuable help; **Marv Grossman** and **Howie Levingston** handled publicity; **Fred Ezekiel**, registration; **Bob Lindquist**, the telethon; and I had fun compiling and presenting the results of our class questionnaire. I have copied of the questionnaire results that were distributed at our banquet. Write to me and I'll send you one. If you do, please add a few lines of where you are and what you are doing since we would all like to know. We missed those of you not at the reunion, and you missed a treasured four days. Try to resolve now that you won't let anything stand in the way of denying yourself this pleasure at our 40th reunion.

Al Roberts has been named senior vice-president of the Washington C31 division of the Mitre Corp. Al, now living in McLean, Va., continues as general manager of that division. Looking at his publicity photograph, I would still recognize Al from our days together as freshman in the barracks. . . . Marilyn and **Herb Scher** were at the reunion. Herb is senior vice-president of technology of the Nevamar Corp., Odenton, Md. Herb has about 30 patents, with some licensed in Europe and Asia. Herb and Marilyn are learning Italian and enjoying travel through southern Europe. . . . **Charles Ellis**, vice-president of Boeing Vortol Co., is managing Boeing's half of a team effort to develop the first operational tilt-rotor aircraft, the V-22 Osprey. He writes that his son Stephen and daughter-in-law Maria are M.I.T. Course XVI graduates.

To Charles H. Spaulding, '51, the Bronze Beaver, the highest award for alumni service to M.I.T.: "After many years of service to the Class of 1951, the Alumni Association's Board of Directors, and the Alumni Fund and other development activities, Spaulding made an outstanding contribution in 1982 by establishing the immensely successful Center for Real Estate Development in the School of Architecture and Planning."

Robert Whittier, now living in Hamilton, Mass., has been elected to his town's school committee. Robert and his wife Sally returned to Hamilton after his retirement from the Monsanto Co. He now works for Maine Post and Beam in Hamilton. . . . **Herb Voelcker** writes that after 25 years as member of the electrical engineering faculty to the University of Rochester and a one-year assignment at the National Science Foundation, he has joined the faculty at Cornell University. . . . **Bernard Rothzeid**, a principal of RKT and B Architects of New York, has been honored with the 1986 Augustus Saint-Gaudens Award for professional achievement by the alumni association of the Cooper Union for the Advancement of Science and Art. . . . The M.I.T. Sailing Pavillion newsletter contains a commendation of **Dick Greenhill** for adding a major equipment donation to his earlier donation of one of their two big boats, the San Juan 24, Hermes.

The only sad duty that the class secretary has is announcing the passing of a classmate. **Mark R. Thompson** of Winter Park, Fla., passed away last year. Our sincerest condolences go to his fiancee, Margaret Stokes.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

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Jim Davidson thoughtfully sent along the unhappy news that **Bill Morton** died August 30 at his summer home on Cape Cod. Bill lived in Larchmont, N.Y., was a business planning manager for IBM World Trade, and a prominent Mason. He transferred to M.I.T. from College of Wooster his junior year, and served in the air force after graduation. Bill received an M.B.A. from University of Michigan, and worked for General Electric for eight years before joining IBM. He is survived by his wife of 34 years, Jean, a son, and two daughters. Another son died in an auto accident in 1980.

In his letter Jim said that both the Mortons and the Davidsons had lived in Ann Arbor in 1954 and had moved to Larchmont about the same time in 1964. On a happier note he continues, "The Davidson family will have its first wedding in January in Philadelphia, our daughter Lea, who is 27. Joanne, who is 26, is a free-lance textbook editor in New York City completing an elementary school music series. Marcelle and I do play golf (she is Ladies Golf Champion; my fourth hole-in-one was last Saturday) and see fewer and fewer M.I.T. friends, as they tend to be divorced, but Sue and **Stan Solomon** were down for a visit. Our firm's consulting, recruiting, acquisitions, and venture capital business moved to Larchmont from Manhattan last year and is now in its 14th year." Jim's firm is the James W. Davidson Co., Inc., of which he is president as well as eponymous hero.

One presidency is not enough for **Gilbert Mar**. He is currently president of the M.I.T. Alumni Club in Tapei and president of EDP Taiwan and Management Consultant, Inc. . . . One presidency may have been too many for **John Zuckernick**, who resigned last spring as president and chief operating officer of Vermont Public Power Co.

Best wishes to you all for the coming year.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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Since we missed last month's deadline, there is more to report concerning the recent activities and honors of our classmates. Your letters and notes are very much appreciated.

In a brief note from **Richard A. Lockhart**, we

learn that he's back in the good old U.S.A. after five and a-half years in Saudi Arabia. He is now managing a 1,000-acre joint public/private resort development project through a contract "with the Commonwealth" (Massachusetts I presume) and the Department of Environmental Management. . . . A note from **E. Richard Hilton** informs us that he is a systems engineer for Ford Aerospace and Communications Corp. in Colorado Springs working on security engineering of large scale computer systems used for processing classified material.

I received a long letter from **Fred Brecher** (current president of our class, just to remind everyone that we do have class officers). He and his wife Sandi were on their way to Nova Scotia (an obviously popular spot since Berna and I went there in August for our vacation, too). They and their family are all doing well, with their daughter at college and two sons still in high school. Fred reminded me that our 35th class reunion is less than two years away, and we need volunteers for the job of reunion chairman, a position which Fred and **Dave Berg** shared for our 30th. If anyone in the New England area is interested, please contact me, Fred, or the Alumni Office.

Fred also spoke with **Jack Dunnous**, a while back. He is involved in a company near King of Prussia, Pa., that produces coloring pigments for use in mortar and concrete.

Richard E. Storey dropped us a note saying that he is now president of the Los Angeles chapter of the International Society of Air Safety Investigators. From what I've been reading of this year's air mishaps, he's probably been very busy—however, apparently not too busy since he's also a tutor in the "Pasadena Reads" program at the local library.

Sometimes it takes a while for information to reach us. For example, an article dating back to February 1986 informs us that **Karl Epple** was honored by the Danbury (Conn.) Hospital's parent company for his contributions to the hospital and its programs as chairman of the hospital's board of directors and trustees. He was recently elected to the new board of DAN-HOSP, the parent company. Karl is general manager at HeliCoil of Danbury, part of Emhart Corp. He and his wife Nancy have three children and live in Bethel.

Finally, we were saddened to learn about the passing of **Frederick E. Jellow** last February. I'm sure many of you remember him, particularly Course VIers. Our sincere condolences to his wife and family.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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Bob Van Meter has been appointed director of Skidmore College's University Without Walls. Skidmore, in Saratoga Springs, N.Y., has had the external degree program since 1970. Bob went to the college in 1978 as an academic advisor, became assistant director of the University Without Walls the next year, and has been the program's acting director for over a year. He had previously been in teaching and administrative positions at the University of Wisconsin in Green Bay, Washington and Jefferson College in Pennsylvania, the University of Maryland, SUNY at New Paltz, and Marist College in New York. . . . **Peter Rigopulos** has been appointed president of the Amicon Division of W.R. Grace and Company. The division, in Danvers, Mass., manufactures products used in biotechnology and health care. Peter has been with Amicon for 22 years, serving in several positions, and has been vice president since 1968. He and his family live in Boxford, Mass.

We greatly regret having to report the death, last September, of **Coley Bresee**. A well-known attorney in San Mateo County, Calif., Coley was dean of the San Francisco Law School from 1978 to 1984. As we reported two years ago, he retired from the deanship to pursue a doctorate in neuroendocrinology at the University of California, San Francisco. Over the years, Coley served as deputy district attorney in San Mateo County and as assistant U.S. attorney in San Francisco. In 1971, he became one of the first attorneys in the country to be appointed judge pro tem in criminal cases. Our sincere sympathies go to Coley's wife, Patricia, and their three children.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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Our first feature '55 M.I.T. faculty member is **Frederic R. Morgenthaler**. Rick has all his degrees from M.I.T. and has made his career at the Institute. From 1984 to 1986, he was the Cecil H. Green Professor of Electrical Engineering and Computer Science. His research is in the field of microwave magnetics. He recently worked on a project for the National Institute of Health using microwaves and other electromagnetic waves to create hyperthermia in cancer tissue in order to induce artificial fever in a localized region. Rick works with the Hyperthermia Center at M.I.T., where ultrasound and electromagnetics are used for the same thing: to kill the cancer. Ann (24), his oldest daughter, graduated from Harvard in physics and is now in the electrical engineering and computer science doctoral program at M.I.T. and is teaching, having been awarded a National Science Foundation Fellowship; daughter Janet (22) graduated from Wellesley College in psychology and is working in real estate. Rick and his wife, Barbara, make their home in Wellesley, Mass. She needlepoints and knits, and has won prizes for her work as a member of the American Needlepoint Guild. In their free time they are music buffs and enjoy concerts. Last year they went to China for two weeks with two other couples; the men were all involved in some aspect of magnetism, and they gave seminars and lectures.

The Wall Street Journal reports that **Robert G. Dettmer** has recently moved from president of Pepsi-Cola Bottling Group to executive vice-president and chief financial officer of PepsiCo, Inc. in Purchase, N.Y. . . . **Dell Lanier Vernarde** continues with her part-time math teaching gigs, but says her major current effort is rebuilding a long-neglected pamphlet file at the Wilmington Library. She reports on her family: Bruce is a third-year student at Harvard Graduate School in medieval history; David, a senior at Yale, is a lightweight rower; Jack is threatening to retire soon from I.C.L. Del sent a copy of the August 4 issue of the *New Yorker*, which has a great story about **Sotiris Kitrilakis** under the title, "Ultimately Offering Olives." Sotiris began in the energy-conversion field and spent over a decade in the Boston area on various programs, including one seeking to develop plutonium as an energy source for a nuclear heart, for the Artificial Heart Program for the National Institute of Health. In 1970, he moved to Berkeley, Calif., with his wife and two children, founded a company called Tecna, and worked to develop a number of medical devices, including a heart-lung machine. After Tecna was purchased by G.D. Searle and Co. in 1975, Sotiris began spending long vacations in Greece; he built a house on Zakynthos, rediscovered Greek country food, and became founder and president of a California-based food-importing company offering a line of products called Peloponnese. That is how he happened to find himself at the 32nd Annual International Fancy Food and Confection Center show at the Jacob K. Javits Convention Center with six kinds of olives and such other Greek delicacies as wild capers, dolmas, and stuffed grape leaves. I wonder if old classmates get free samples?

Roger Reiss, a senior staff engineer for Lockheed Missles and Space Co., Inc., has found a professional-society home for the several thousand mechanical engineers (some say as many as 10,000) who work on or with optical devices. The Society of Photo-Optical Instrumentation Engineers (SPIE) Bulletin, *Optical Engineering Reports*, has several recent articles about the progress of an ad hoc working group, chaired by Reiss, formed to incorporate optomechanical engineers into SPIE. Many of the established members of their professional community were precision instrument engineers whose work led them into optomechanical engineering. In fact, Reiss says, "anybody who is an optomechanical engineer should know precision engineering." The technical information an optomechanical engineer needs will be greatly facilitated by the society through a variety of means: informed exchanges with other engineers, tutorials, *O.E. Reports*, proceedings, and other society publications. If you are interested in learning more about their new group, contact Roger: No. 200, 777 Middlefield Rd., Mountain View, CA 94043. . . . The February 1986 *Bulletin of the American Physical Society* informs us that **Henry W. Kendall** has won a Fellowship Certificate from the American Physical Society, "for his crucial contributions to the study of elastic and inelastic electron scattering, and for his important activities in the field of nuclear reactor safety and nuclear disarmament."

I regret to report the passing of two of our classmates: **Gerald Perloff** in December 1985; and **Robert A. Schlomann** of Columbus, Ohio, in February 1986. We have no information other than the dates of death. Our condolences to the families and friends of both of them.—**Robert P. Greene**, Eastern Co-secretary, 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson**, Western Co-secretary, 201 E. 79th St., Apt. 11-I, New York, NY 10021

58

As we go to press, the Red Sox are still in contention, the America's Cup is in the preliminary rounds, and the off-year electioneering is in full swing. By the time you read this column in January, we'll all know how our bets and hunches turned out. Happy New Year!

Starting off the new year right is a "first letter to the class secretary" from **Frank Galeener** that brings us up to date. He writes, "After leaving M.I.T., I worked as an experimentalist for three years at Lincoln Lab, then for three years at the Francis Bitter National Magnet Laboratory. In 1959, I was married to Janet Trask, a student at Mass. General Hospital, whom I had met at a blind date square dance in Walker Memorial. We moved to Lafayette, Ind., where I began working towards a Ph.D. in solid states physics at Purdue, and Janet became a faculty member and chairperson of the Department of Nursing. I joined the Xerox Palo Alto Research Center in 1970 and later managed the Crystalline and Amorphous Semiconductor Research Area for five years. Now I am a principal scientist specializing in the physics of amorphous solids. In 1985, I was elected a fellow of the American Physical Society for contributions to the understanding of the vibrational excitations, morphology, and atomic scale structure of glasses and amorphous solids. Since coming to northern California, Janet has earned an M.A. in higher eduction from Stanford and has held teaching and supervisory positions in nursing while we have raised two sons. Keith is a sophomore biology major at University of California, San Diego, and Matthew is a junior in high school, with special interests in football and wrestling. We often think fondly of our years in Cambridge."

More news from our West Coast contingent comes from **Toni Schuman** who writes, "I attended the M.I.T. National Alumni Conference in Orange County, Calif. last fall, where we all had our arms pleasantly twisted by **Glenn Strehle** and his financial cohorts. Seriously, they really did a great job—the meeting itself was truly enjoyable, very well organized and with lots of good information provided by the Cambridge contingent.

"Currently, I am managing a large army contract at TRW, traveling about the country (mostly to places that begin with the word "Fort") and having a ball. My most noteworthy achievement was learning to drive an M113 armored personnel carrier. It's really great on the freeway! I am especially proud of my daughter, Jennifer, who is currently at M.I.T. as a graduate student in architecture.

"Incidentally, the class of '58 may be setting a record for mother-daughter teams. **Nancy Greene Berman**'s daughter, Rachel, is a junior this year in Course VIA. Nancy and her husband Arnold, '57, recently moved to California from Washington, D.C. She got her doctorate in statistics from American University and worked there in group operations.

"While at the alumni conference, I ran into **Ed Bell**, who was one of the few '58 representatives there. He is now selling commercial and industrial real estate for Coldwell Banker, and living at the beach in Santa Monica. This summer he climbed Mt. Whitney with his two sons and made it all the way to the top. In his spare time, Ed continues to play the recorder and to do some painting."

That's our West Coast report, folks. We'll be back next month with equal time for the rest of the country.—**Michael E. Brose**, Secretary, 534 E. Broadway, South Boston, MA 02127

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I am writing these notes while sitting by a window of my 20th floor room at the New Orleans Hilton, overlooking the "muddy" Mississippi River. It's a spectacular and fascinating view. I'm enjoying watching the river traffic flow by below—the long river barges filled with coal, cement and other cargo slowly pushed by stocky, ugly-looking tug boats, the auto ferry carrying commuters to and fro from the West Bank, and the paddle wheel steamers conveying tourists on a leisurely river cruise punctuated by the shrill sound of boat whistles and steam calliope music. Bess is attending the Interscience Conference on Antimicrobial Agents and Chemotherapy, and I'm on vacation. We have come to New Orleans after spending three days with Bess's relatives at Gulf Shores, Ala.

A sparse selection of items again this month. I received a newsy note from **Jim Brown**, who writes that his daughter Alice graduated from M.I.T. in June (Course XVIII) and is doing graduate work at the University of Washington (Seattle). Jim and Dotti have been married for 27 years. They had a nice visit last February from classmate **Paul McKeown**. Jim says his dad (class of '30) is still working as an electrical engineer in Lorain, Ohio at age 78. In addition to the three generations of M.I.T. grads on his side of the family, Dotti has an uncle, grandfather and two great-grand uncles who are also M.I.T. grads (back to 1893!). . . . In a recent newspaper clipping was an announcement that **Jan Northby**, professor of physics at the University of Rhode Island, had been awarded a Fullbright Scholarship to the Max Planck Institut for the 1986-87 academic year. His research will involve cluster beams and low-temperature physics. Before coming to U.R.I. in 1970, Jan conducted low-temperature physics research at the University of Oregon. . . . **Nam Suh**, who is on leave from the Institute as assistant director for engineering at the National Science Foundation, was awarded an honorary Doctor of Engineering degree from Worcester Polytechnic Institute. . . . A recent brochure from the M.I.T. Enterprise Forum announced a case presentation by **Chuck Staples**, president of Viking Technologies, Inc., Newport, R.I., makers of products for owners of personal and professional computers. Their primary product is "Uptime," a monthly disk-based publication for Apple II and Apple McIntosh users. Similar publications for the IBM PC and Commodore users are in the early stages of development.

To Robert A. Muh, '59, from Joseph G. Gavin, Jr., '41 (right), the Bronze Beaver, the highest award for alumni service to M.I.T. Muh was cited as "a dedicated, thoughtful, generous volunteer who typifies the alumnus with whom all segments of the M.I.T. community are delighted to work."

That's all the news for this month. Ron and I still have our streak going, and it's up to you to make sure that we continue. So, as the sun slowly sinks into the west, please send in your cards and letters with any news or info on yourself or any of our classmates.—**Art Collias**, Co-Secretary, 24 Hemlock Dr., Canton, MA 02021, (617) 828-5073; **Ron Stone**, Co-Secretary, 116 Highgate Pl., Ithaca, NY 14850 (607) 257-2249

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A charming part of reading through this section of *Technology Review* is the quick tour one can make through the stages of life. Look at the class of '81—they are all getting degrees, married, and having kids. The class of '71 is rising rapidly through the corporate or academic ranks, traveling and having more kids. Our class is nearing the corporate top, getting tenure and looking on proudly as the kids graduate from college and have kids of their own. These thoughts came to mind when a clipping from the Lynn (Mass.) *Daily Evening Item* came across my desk. It shows that some people don't fit the mold. **Alan Martin** got married last April to Patricia Carley of Swampscott. I haven't seen a wedding announcement of a classmate in the paper for 15 years. Congratulations, Alan. There's life in the old class yet! . . . If further proof were needed, a note from **Paul Robertson** proves the point: Paul was remarried a year ago. He is a systems engineer working on military and government communications. He married a coworker at Calculon Corp., Pat Scott. In off-hours Paul is an accomplished racewalker, having won several national 40+ marathon championships and one open (100 km) championship. He says he hoped to see **Tom Knatt**, a former national champion, at the Nationals last fall. . . . At Dicomed Corp., **Ken Hootnick** is chief executive officer as of last June. Although Ken started in chemical engineering, he now is something of an expert in computer graphics, a product Dicomed makes and sells all over the world. . . . As I reported a couple of months ago, **Sanford Weiner** died in Houston, at the M.D. Anderson Hospital, last June. A press release from Proctor and Gamble, where Sandy was a group vice-president, attests to the great respect felt by his fellow workers. I know the whole class sends their profound regrets to his wife Joan and their two girls, Michelle and Susan.

As promised, I am beginning a series of notes on the results of the class questionnaire. This month I'll start on responses to the vital statistics part. We sent out 634 questionnaires and heard from 241 people by the late summer. Let's assume that this sample is representative of the class as a whole (even though we know it isn't). 85% of us are married, 10% divorced and just a few widowed. Three quarters have been married only once, 15% twice, and one classmate has been married thrice. The most kids resulting from these unions was eight, with the average family containing 2.5 children. More than half (58%) of the class spouses work outside the house. That compares with 40% five years ago. We are a pretty rich bunch. The median yearly family income was $85,000, and we estimated our financial assets to be more than $400,000. When you include a house worth $220,000, we get close to being millionaires. Who says an M.I.T. education isn't worth $1,700 (back in 1961)? That house probably sits in a suburb (54%). And it is probably inhabited by a man who thinks he is overweight (56%) but sees himself to be in pretty good physical shape. Not great—just pretty good. On Sunday (50%) (or Saturday, 20%) a lot of these people feel guilty because they don't seem to attend religious services. On a scale of 1 to 5 our classmates see themselves as not very religious (2.5). Our "typical" classmate (let's call him Joe) is a homebody; seldom going to the theater, movies or even to other people's houses (about once a month for each). He sits in front of the tube for a little over an hour a day. When the television is off he reads a couple of books and around eight magazines a month. When old Joe Tech exerts himself, he tends to ski (39%), swim (36%), or jog (34%). Most (64%) of us feel that the time away from work is important although most (58%) don't think they have as much time away as they would wish. As night sex is pretty important to Joe (4 on a scale of 5) and he and his wife have been faithful to each other (only 10% infidelity). Apparently we have very few sins. Only about 10% smoke cigarettes, pipes or cigars. Only 20% drink frequently, although most people drink on off moments.

That's it for now. We'll have more intimate details of Joe's personal life next issue.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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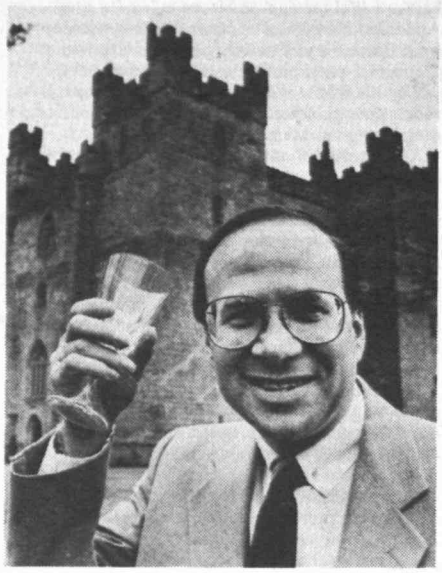
I recently received a nice note from **Paul Shapiro**, who decided he "would *finally* write" (my emphasis) for these class notes; late is better than never. Last January Paul married Melissa Friedland, a graduate of University of Texas and its LBJ School of Politics. He is an environmental engineer with EPA's Office of R&D, working on indoor radon. (I hope he does good work, because the Baltimore area is supposed to be full of radon-infiltrated homes.) Melissa is in the EPA Superfund office. Paul is currently president of the M.I.T. Club of Washington, D.C., in which city they live, on Seventh St., S.W.

You may recall that a year or so ago I reported that **John Castle** has given a large contribution to the Institute. In early September the *New York Times* reported that John had resigned his position as CEO of Donaldson, Lufkin and Jenrette, which is the brokerage subsidiary of Equitable Life Assurance. He said he had decided while on a Far East vacation to start his own venture capital firm. We wish him good luck.

Dale Miller tells us he has been at Lawrence



Castlekeepers Stuart E. Madnick, '66, professor in the Sloan School of Management at M.I.T., and his wife, Julia Horlov, have remodeled and opened their recently-acquired 14th century castle as a luxury hotel. Langley, set on 10 acres of wooded grounds in northeast England, is believed to be the oldest castle being operated as a hotel in England.

Livermore National Lab doing mircostructures, molecular beam epitaxy and concept development for opto-electronic ICs. He has learned Norwegian, and enjoys trading stories with his wife, Kari's, family in their native tongue. Older son, Sven, started last fall at UC Berkeley. The Miller family lives in Livermore, Calif.

Reporting from Northwestern University is **Steve Fisher**, who has taught there 17 years, and is now a full professor. He has had sabbaticals in Wisconsin and Haifa, Israel. . . . **Jim Champy** is still with Index Systems, in Cambridge, and is currently vice-chair of the board.

The American Physical Society has appointed **Gary Feldman** a Fellow: "For contributions to the discovery and study of new mesons and leptons." . . . Rensselaer Polytechnic Institute, Troy, N.Y., has announced promotion of **John McDonald** to full professor. John has been at RPI since 1974, doing research in computer hardware for long-range sonar, nuclear reactor monitors and medical instrumentation.

Now, please engage your favorite character-recording tool and transmit a chronicle of your exploits to your colleagues. In other words, please write.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218; (301) 889-3890

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Greetings and good wishes for a happy and healthy 1987. I'm writing this column at the end of September 1986, in between keeping track of a couple of government contracts which close at the end of the fiscal year. And then there's always starting the next year's contracts, maybe—what is his thing called a "continuing resolution"?

My first duty is to back-track to the August/September issue: No matter what the column said, my wife's name is not Louis. Actually Louise took it all very well—the only mangling of her name which she doesn't appreciate is when it comes out "Lousie."

There are just a few items in the news bag. Several of our classmates were awarded Fellowship Certificates at the 1986 meeting of the American Physical Society. The honorees and their citations follow: **Verne Jacobs**, for outstanding calculations and fundamental analysis of photoionization and its incorporation together with dielectronic recombination and other processes in application to plasma diagnostics; **Richard McFadden Martin**, for his contributions to theoretical physics in the understanding of the relationship between the electronic properties and the structure of condensed matter; **William Douglas Watson**, for pioneering developments in the theory of astrophysical atomic and molecular physics which have greatly advanced our understanding of interstellar masers, molecule formation and other processes at the forefront of astronomical observation.

A press release from Bucknell University announced the election of **Grant Wilson** to the University's Board of Trustees. Since 1975, Grant has been a specialist in leveraged buyouts. Prior to that, he was involved in the financing and development of cable television systems. Grant also is serving as a trustee of Brewster Academy and of Nashoba Brooks School and is president of the Carlisle (Mass.) Conservation Foundation. . . . **Bob Popadic** is a co-author of the Second Edition of "The Bank Director's Handbook." He is a senior member of the Financial Industries Section of Arthur D. Little, Inc. Bob specializes in planning, marketing, finance and management information, particularly as they relate to financial organizations.

The final item relates to our 25th reunion. As this column is being written, we're closing in on the 25th anniversary of the fire which destroyed the commercial block on Mass. Ave. which housed WGBH-TV, Larry's Barber Shop, and other establishments (does anyone remember the names of any others?). Looking to the future, **Bill O'Halloran** has volunteered to be the Boston area coordinator of our reunion, and he needs help. Please call him at (617) 942-1203 (daytime) to offer ideas and/or your services.—**Joe Kasper**, Secretary, 3502 Idaho Ave., N.W., Washington, DC 20016

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Only a few notes this month, but at least you will know that the class of 1965 is still around. . . . **George McQuilken** has left Spartacus Computers and is now a co-founder, president, and CEO of Software Productivity Research, Inc. of Cambridge. . . . **John Woods** spent the 1985-86 academic year on a sabbatical at the Electrical Engineering Department of the Technische Hogeschool Delft. John has also been elected to a three-year term on the advisory committee of the IEEE's ASSP Society. . . . **Martin Breidenbach** has won a fellowship certificate from the American Physical Society "for his outstanding contributions to detector development which were crucial to the discoveries of the psi and psi-prime."

So much for January. Let's try for more notes and letters in 1987.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

Congratulations are in order for several classmates this month.

A note from **Joseph Patterson** reports that he and Betty celebrated the 20th reunion with the birth of their second son, Benjamin Frank. They report that it was a good reunion. . . . **John J. (Jack) Elder** has a new daughter, Catherine Margeret, as of April 3. He is still living in Brookline. . . . **Paul Demko** has been promoted to vice-president, research and development, at Wang Laboratories.

The Optical Society of America has named **John F. Reintjes** of the Naval Research Laboratory in Washington, D.C., a fellow of the Society. He was honored "for his contributions to nonlinear optics in the areas of optical frequency conversion and stimulated Raman scattering." . . . **Paul F. Liao** has won a fellowship certificate from the American Physical Society. The citation reads: "For contributions to the field of nonlinear optics which include pioneering work in Doppler-free two photon spectroscopy, degenerate four-wave mixing, coherent transient spectroscopy, and surface-enhanced nonlinear effects." . . . **Chester L. Nachtigal** writes that he recently accepted a position as product manager with Kistler-Morse Corp. of Redmond, Wash., which sells a line of semiconductor strain gauge transducers.

It's good to see that the class of '66 has been keeping busy. Keep up the good work. And let us hear about it. As for me, I recently left Xyvision, where I was one of the co-founders, to start a software consulting company. Pam and I have two daughters now, plus an assortment of cats and goldfish.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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I was pleased to receive a letter from **Kamal Meattle**, who received his S.M. from the Sloan School in 1967 and now lives in New Delhi. He is currently engaged in promoting a new venture that will produce low-cost, edible-oil based, flexible packaging for broad use in India, which would reduce the use of imported tin plate. The project is expected to cost $40 million and to generate foreign exchange savings of $250 million in the first ten years. Operations should commence by March 1988.

Kamal and his wife Anite were married in 1971 and have three children, two boys and a girl. Kamal is a director of several companies in India, belongs to numerous professional, business, and civic organizations, and is a member of the Delhi Golf, Gliding, and Flying Clubs. He has served as president or chairman of several of these organizations. Of particular note, he is treasurer of the M.I.T. Alumni Association of India. Also, he holds a number of Indian patents in the field of packaging and has written several articles in this field.

Richard Haberman has been named chairman of the Mathematics Department, Dedman College, Southern Methodist University, where he is an associate professor of mathematics. . . . **Robert Clagett** retired from the AT&T Engineering Research Center in Princeton, which he headed, and is now dean of the College of Business Administration at the University of Rhode Island. Robert was elected to the National Academy of Engineering in 1986. . . . **Mark Grossman** recently passed the five-year point in his consulting practice and has moved into a new home in Agoura Hills, Calif. His wife Susan handles all office and administrative activities. They have three children—Jennifer, who had her bat mitzvah last May, and Jonathan and Jacyln, who will soon reach similar milestones in their lives.

It is sad for me to report the death on May 24, 1986, of **John Ellenwood** of Virginia Beach, Vir.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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Daniloff arrives and Zakharov departs within 20 minutes of each other just a few miles from where these words are keyed—Dulles airport. Does anyone even remember them now? Strange happenings in these muggy parts.

John Black writes, "I have just assumed a posi-

tion of professor of communications computing, and technology at Teachers College, Columbia University. I have established the Intelligent Learning Environments Laboratory here and am researching everything from design of educational texts to educational TV, to Intelligent Computer Assisted Instruction." . . . **Joseph Batty** has been associate director of the Utah Water Research Laboratory since 1983. He returned to teaching and research as a professor of mechanical engineering at University of Southern California in 1986. . . . **Mitchell Wand** writes, "Effective 1985-86, I am now associate dean of the College of Computer Science at Northeastern University, right here in Boston, and am settled happily in Newton."

A tiny snippet of paper tells me that **Roy Folk** is now executive vice-president and general manager of the Software Products Division of Ashton Tate in Torrance, Calif. . . . Our own cosmological classmate colleague ("C^{3}") **Marc Davis** has been awarded a fellowship certificate by the American Physical Society for his significant contributions to the observational study of galaxy clustering and the implications for the nature of dark matter in the universe." Speaking of invisible lack of substance, recent studies have in fact shown that there is more invisible dark matter flying through the air in Washington, D.C., than in any other U.S. city south of Greensboro, Vt. It's a fact!—**Eugene Mallove**, Secretary, 11902 Paradise Ln., Herndon, VA 22071

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Joan F. Etzweiler is section head in the Nuclear Engineering Department at the Shoreham Nuclear Power Station on Long Island, N.Y. She recently gave birth to her third daughter and spent six months in Europe with her family participating in her husband's sabbatical from Columbia University. . . . **Thomas Morbus** is associate director of the M.I.T. Industrial Liaison Program (ILP). Formerly, he was assistant director of the chemical, materials and biological science division of ILP. . . . **O. Reid Ashe, Jr.**, is general manager of the Wichita (Kan.) *Eagle-Beacon*. . . . **John N. Drobak** is professor of law at Washington University in St. Louis and has been appointed associate dean. He received his law degree from Stanford University and was formerly associated with a law firm in Connecticut and clerked for a judge in the California Court of Appeals. He is an expert on the legalities of economic regulation.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin and Larmore, 2200 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

71

Frederick J. Leonberger, of the United Technologies Research Center, has been elevated to a fellow in the Optical Society of America, a nonprofit education and scientific society devoted to the advancement of optics. Fred was named as a fellow for pioneering contributions to optoelectronics and integrated optics. . . . **Bob Marshall** left his position with Texas Instruments in Dallas as a patent attorney, where he had been doing patent work since 1980 for all sorts of microprocessor technology, to work for Krass and Young, a small firm of patent attorneys which has its main offices in Troy, a suburb of Detroit. The firm is branching to Ann Arbor, where Bob will head the branch office. His wife, Kathleen M. Goudie Marshall, prompted the move from Dallas because her family is in the area and she did her graduate work at the University of Michigan. Bob and Kathy met in 1982 while she was doing work in synthetic speech for T.I. in Lubbock. They married in 1984 and have worked in the same building and car-pooled to work for most of their married life. Kathy is planning to start a consulting business in synthetic speech.—**Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

73

It doesn't seem like nearly 14 years have passed since our graduation. I remember it as if it were only eight. Well, maybe 10. Our feature letter of the month is from the "Count," **Dennis Intravia**, who insists we always have the shortest column in the recent class group. He's right, you know. He also knows you can't write without news. Dennis started a company called Mind's Eye Technology, involved in electronic voice input/output. He is married four years, with a son, Matthew. He maintains regular contact with fellow Theta Chis **Wes Grandmont**, **Bill Billing**, and **Tom Lydon**, but won't pass on any news, suggesting they "get off their butts and write." (At least Tom does.) By the way, I know Dennis bowled because he, Wes, and Bill were the famous Theta Chi "A" team when the famous Phi Delt "A" team was Ray Mayer, '72, Scott Berdell, '68, and yours truly for the same four years.

Lida Morawetz Jeck gave birth to her second child, Daniel Matthew, who joins 3-year-old William. Lida has a private psychiatry practice in Durham, N.C. . . . **Doug Moran** is working for S.R.I. International in Menlo Park, Calif., and is currently in Cambridge, England, for a year with S.R.I.'s new Laboratory for Computer Science, a response to the Japanese "Fifth Generation" effort. . . . The February 1986 *Bulletin of the American Physical Society* announced a fellowship for **Stephen Jardin**, for "significant contributions to the understanding of confinement in axisymetric systems through analytical formulation and numerical implementation of stability and transport codes, and for the investigation of spheromak formation."

Little is new on the home front; the kids are in a new school this year and enjoying it. Remember—18 months to the 15th reunion. Write!—**Robert M.O. Sutton, Sr.**, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74

We have arrived at that age where we're old enough to know what we want and how to get it. I felt that while sitting at the Class of '74 table at the June Technology luncheon with classmates **Patti Newbold** and **Kenneth Miller**. Another thing I noticed was how young-looking seemed the alumni attending their 25th reunion.

I spent a fascinating morning with **Carl Howe** recently, discussing parallel processing. Carl manages the operating systems development group at Bolt, Beranek, and Newman Advanced Computers, Inc., in Cambridge. Their machine, called Butterfly, has an operating system called Chrysalis (and when you connect them together you get a Butterfly Net). Carl's group is building extensions on the software and supporting the installed base of 60 machines. . . . A note from **Jamie Silverstein Stolper** says she is a self-employed business consultant who specializes in the appraisal of software and other high-tech intangible assets. She lives with husband **David** and sons Harold and Samuel. . . . **Walter Gibbons** received the M.S. degree in management from the Sloan program at Stanford. Celeste and he welcomed Melanie into the world last November to join Adam. Walter is managing software development for A.T. and T. Bell Labs in Naperville, Il.

The other side of birth announcements, and something I have thought about for seven years as your class secretary, has now happened. **Richard C. Parker** passed away on July 4th. Dr. Parker was a member of Chi Phi and also active at *The Tech*. He was a prominent research microbiologist and faculty member at Columbia University's College of Physicians and Surgeons. . . . It is with regret I note the passing of **Rod Gretlein** in August. Rod was an assistant professor of economics at Rutgers University. He is survived by his son Alex and his wife Patty Newbold.

Cynthia and **Ken Skier** and their company, Skisoft, Inc., will be marketing a desktop publishing product for IBM PCs through Ashton-Tate. The product will tentatively be called "Skisoft Publisher." Ken says its "pleasant as hell being your own boss," and frustrating. Their company, which also includes Nick Kallas, '76, has a few other packages on the market for other hardware, but this one is potentially a very big deal. . . . I've tried a dozen times to get hold of **Bill Parker**. Bill's electronic sculptures, called Starsculptures, are showing up everywhere. Starsculptures are spheres of a noble gas with a high-voltage discharge electrode in them. They give off lightening-like discharges which you can watch through the glass sphere. I saw a starsculpture at Epcot Center when I was down there in August. Also, there was one in the movie "Ferris Bueller's Day Off." They're selling in art galleries for two grand or more apiece. . . . **John Hurd** has recently joined Language Processors, Inc., in Waltham as vice-president of marketing. . . . **Steve Jordan** and family have sold their house in Palos Verdes Estates and are moving north to the bay area. Steve does strategic planning for Fairchild. . . . Terri and **John Viggers** are involved up to their shoulder belts in auto racing. John, a professional mechanic, races Formula 1 cars in the south California area. And "after 12 years of marriage," says Terri, "it's still getting better." . . . A note from **Danny Parker** says he and wife Janice have recently moved to the Dallas area where he is responsible for corporate software development in all IBM areas for Electronic Data Systems Co.

Does anyone have any M.I.T. trivia to share? For example, Herbert Kalmus, '04, invented a color film process and named it Technicolor, after his alma mater. And another: the term "ecology" was coined by Ellen Swallow Richards, class of 1873. One last item: The catamaran was patented by Nathaneal Hereshoff, class of 1870, one hundred years ago this year. So, before you go sailing off into the sunset, put your news on paper and send it to me.—**Lionel Goulet**, Co-Secretary, 21 Melville Ave., Dorchester, MA 02124; **Richard Sternberg**, M.D., Co-Secretary, Box 3209, Alexandria, VA 22302

To H. Dubose Montgomery, Jr., '71, from Joseph G. Gavin, Jr., '41 (right), the Bronze Beaver, the highest award for alumni service to M.I.T. He "never turns down a request," said Montgomery's citation, bringing "impressive initiative, effective leadership, and persistent follow-through" to countless M.I.T. activities.

World Series: If They Had Only Played In Anaheim, He Would Have Been There

By Barry S. Surman, '84

To my right, Enrique snores in B-major. On the left, Matt is dissonant in C. Two thin blankets separate my posterior from the pavement. My socks are wet and my feet numb. This is a camping trip like no other. *We are going to the World Series.*

Never mind that the Angels are packing for one last road trip to Fenway. Never mind 1979. Never mind 1982. Never mind that Mr. October looks more like December each time he steps to the plate.

It is, technically speaking, Monday morning—3:42 A.M. We are encamped on the asphalt plain—five, maybe six hundred strong. By dawn, the crowd seeking numbered blue bracelets—strips of plastic that will allow them to buy Series tickets on Wednesday morning—will number at least 2,000.

But that is of little concern to this phalanx of fans, the first 50 to set their lawn chairs on a grassy knoll outside Anaheim Stadium, alongside State College Boulevard, before the ink was dry on Sunday's scorecards.

These are the hard-core. And they are exhausted, sacked out in sleeping bags on cheap chaise lounges, the tension of those last three innings—homers and hit batsmen, the RBI single, the sacrifice fly—finally releasing its grip.

A few still stir, though. They are the self-appointed lawmen of the line, the protectors of order who throughout the afternoon and night have and threatened and persuaded and intimidated those who would violate the sanctified queue. They sit upright on their lawn chairs, wrapped in blankets, or they pace alongside the line, hands pushed deep into pockets.

Before stadium officials allowed us into the parking lot about midnight, allowed us to make camp alongside sawhorses and fences, we saw the line ahead of us swell with strangers. Once I stood 20th in line. Now I lay, shivering, about 120th.

As I try to sleep, a half-dozen men drink beer and toss a football under the harsh, white street lights. On the glowing screen of a 5-inch, battery-powered television, Gammera the Invincible swings around a horizontal bar. A helicopter buzzes past.

But rumors have begun to circulate again, rumors that they will begin issuing numbered bracelets before the appointed 6 o'clock hour—at 4, maybe, or 4:30.

Sunday, such paranoid tales flew furiously: Anaheim Police wouldn't let us stay here; automated lawn sprinklers would drench us; priority numbers would be issued randomly; we would have to sprint a third of a mile and battle incoming cars to get in the *real* line for wristbands.

An outdoor bathroom, which the stadium has opened "for our convenience," is a half mile away. I hike off in the general direction, but give up halfway. The oleanders will keep my secret.

The line is waking when I return. People take turns dashing to Winchell's or Naugles for danish. Someone fires up a pot of water on a Coleman stove.

A latecomer offers Matt ten bucks to cut in line ahead of us. Everyone has his price, but this guy's not even close. Later in the morning, a well-dressed man has the gall to walk over and offer me $5. The crowd around me has a good laugh when I announce his generous offer.

A woman walks alongside the line, heading toward the front, obviously looking for a spot to nudge her way in. But this crowd can feel the plastic bands around their wrists, can see the words on their tickets: World Series, Anaheim Stadium. She only tries to cut in once.

"It's scary up there," the woman announces as she again walks past, this time toward the back of the line. Each attempt to jump the line is met with a louder, more threatening response.

A man who left hours ago, to eat hot food and sleep in a soft bed, tries to rejoin his buddies in line. "No more friends," someone screams and a chant is born. "No more friends!—No more friends!—No more friends!" He leaves.

ILLUSTRATION: JON McINTOSH

No more friends.

Another yahoo makes a run at the barricades. The crowd hollers for a security officer, who sends the villain to the end of the queue, a third of a mile across the asphalt parking lot. "Go to bracelet hell," a heckler calls after him.

This is bracelet hell.

After 14 hours, the line shuffles forward. Security guards, understandably surly at this hour, pull the precious bracelets tight around eager arms. Do not bend, fold, spindle or mutilate, they warn, or you'll lose your priority for buying tickets.

Faces I've come to recognize walk past, finally, trying to remember where they left their cars. Lawn chairs are slung over sagging shoulders, blankets rolled under arms.

What'd you get? "Five" and "twenty-three" and "eighty-seven" come the responses, often as not punctuated by a right wrist, raised to prove it really had been tagged with a bright-blue band. *See you Wednesday.*

My turn. For the next 51 hours, call me Number 131.

As I leave, I'm tempted to drive out the main gate, curious to see the line, still growing, now stretching at least half a mile around three sides of the stadium's west parking lot. Instead, I head straight for the freeway. A brilliant, golden dawn lends the coastal mountains a dramatic silhouette as I head home to a hot shower.

And in My Hand,
Real World Series Tickets

Wednesday morning, I return to buy the coveted tickets, eight-and-one-half hours before Roger Clemens takes the mound in Game Seven. Monday's vigilantes wear business suits now. A strange festivity, fueled by catering-truck coffee, has supplanted the communal ugliness I associate with this parking lot.

We buy our tickets, compare our seats with neighbors from the line. *See you at the Series.* We rush to work, rush home to watch the game.

Mercifully, ticket refunds are available at local banks. We need not return to Anaheim Stadium.

I know my comrades of the line only by their first names: Larry. Al and Mike. Peter, Karen and Rose. Manny. Burt. I don't expect to see them again.

Well, maybe next year.

BARRY SURMAN, '84, is a reporter for the Los Angeles Times. *He was editor of Volume 103 of* The Tech.

75

A few items to herald in the New Year: **Jeffrey S. Wilson** tells us that he is product manager at Convex Computer Corp., a supercomputer manufacturer located in Richardson, Texas. . . . **Edward T. Saad** writes, "After working for Ashland Oil, Inc., as general manager for their activities in Saudi Arabia, I hold the position of technical advisor to H.E. the Governor of the Organization of Petroleum and Mineral Resources (PETROMIN) in Saudi Arabia since 1982." . . . I note in an article from the July 16 *New York Times* that classmate **Norman Sandler** and his wife Raeanne attended a state dinner at the White House in honor of Prime Minister Mohammed Khan Junejo of Pakistan during his visit to Washington this past summer. Norman is a U.P.I. White House correspondent. . . . Finally, via a Pan Am news announcement, I learned that **Robert W. Mann, Jr.**, was named general manager, marketing, at Pan American World Airways, a post that includes responsibilities for Pan Am's marketing planning, direct marketing, and promotion efforts. Robert joined Pan Am in September 1985, and was formerly system director, marketing plans and programs. He will now be responsible for Pan Am's direct consumer, agency and employee marketing programs, cooperative marketing with travel-related concerns, market research and analysis, as well as developing Pan Am's own marketing plans. In addition, the announcement mentions that Robert serves as an outside director of Airline Automation, Inc., a Washington, D.C., based firm specializing in the development and marketing of schedule and planning system software for the IBM PC.

That's it for now. Wishing you all a healthy and happy 1987, I remain your faithful secretary—I have faith that many more of you will write to me this year.—**Jennifer Gordon**, Secretary, 18 Montgomery Pl., Brooklyn, NY 11215, or c/o Pennie and Edmonds, 1155 Avenue of the Americas, New York, NY 10036

76

We have gotten some news via the mails. We could always use more, so please pick up a pen today and write.

Douglas Hanahan has been awarded a grant by the Diabetes Research and Education Foundation to create a computerized analysis of insulin-producing cells in the pancreas. This analysis could reveal key alterations that these (beta) cells undergo in Type I, or insular-dependent, diabetes. We wish him much luck.

Bill Phipps, M.D. has been named an assistant professor of obstetrics and gynecology at the University of Minnesota Medical School. Bill got his M.D. at Johns Hopkins, and has chosen to specialize in reproductive endocrinology.

Allen Razdow is the vice-president and co-founder of MathSoft, Inc., located in Cambridge, Mass.

Jeslie Charmak sent a brief note: "Went to the 10th reunion. Met many old friends, missed even more. Went to Bull and Finch, site of the original 'Cheers' TV show inspiration. Whale watch was whaleless—too early in the season."

A postcard from **Dan Dershowitz** and Debbi Gross '77, tells of their vacationing in Israel. Upon returning, Dan is starting a new job at GAF.

From **Jerry Dausman:** "First, I left my job at Grant Thornton. I decided to join a small consulting firm, Engineering Management Consultants. I was the third full-time employee when I joined in June, but we have since doubled in size. I expect we will double again by this time next year. By then I will be part owner of the firm. We do two types of consulting, mainly for real estate clients: computer system selection and installation management for large clients, and we act as a developer-for-hire for very small clients. The development work we do is really exciting. The small investor is typically a guy who has three or four commercial acres out in the suburbs but doesn't know how to get zoning or permits, needs help with financial projections for the bank loan, doesn't know what type of contract to get with his architect, contractor, engineers, etc. The second, and most important event of the summer is the birth of our first child. On August 28, Amanda Ruth was born. Dad was present at the birth, and mom, Barbara Davies, Wellesley '79, did fantastic considering we didn't practice our childbirth lessons very much and this was the biggest baby born in either family tree (9 lbs.)!" In case anyone wishes to look up the Dawsman family, they are at: 1112 N. Utah St., Arlington, VA 22201.

Insofar as the Carp family is concerned, daughter Shana is growing like a flower, wife Rita is fully recovered and your secretary has been very, very busy between family and business. On the business front, by the time you read this, Stalco Futures, Inc., will be up and operating with me as its president. It is an introducing futures brokerage firm largely for hedgers (institutional) from the shipping trade, and for hedgers of interests rate and foreign exchange exposures. We do have speculative business as well. If any of you are interested in either futures hedging or speculation in any market, please feel free to give me a call. We will welcome your inquiries.—**Arthur J. Carp**, Secretary, Stalco Futures, Inc., 225 W. 32nd St., S. 1705, New York, NY 10122, (212) 736-1960

79

A happy new year to all classmates.

Only one piece of news this month, and regretfully it is bad news. **Steven Rodgers** passed away on June 13, 1986, in Los Angeles. Steven got his Ph.D. from Berkeley in 1985 and spent a year as a postdoc at University of Southern California prior to his death. Our sincere sympathies go to his parents.

I hope to hear from more of you during this new year.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

80

The class "mailbox" has been pretty empty the last month or so. I hope that means everyone's had a busy, fun summer. (Note: it's now just September! which reminds me to remind you that there will always be *at least* a two month delay between the time I hear from you and the time the news is published.) I'm looking forward to hearing from lots of people this fall on what you did on your summer vacation and other important milestones in your life.

I received a short note from **Paul Heckbert**: "Since graduation I worked for five years at the N.Y.I.T. Computer Graphics Lab, took a few months off to travel around the world and go trekking in Nepal, and I'm currently doing computer animation research and development at Pixar in San Rafael, Calif. Next year I plan to enter graduate school in computer science. I implore my classmates to refuse all S.D.I. work." . . . **Paul Dennig** is a former senior design engineer for Monolithic Memories, Inc., and a current student at Stanford studying for a Ph.D. in materials science. He says "travels include Nepal." Sounds like it's going around! . . . Also in the going-to-graduate school category is **Linda Jo Dolny-McCaffrey**, who started at Stanford Business School this fall.

Two people at the other end of graduate school: **Ronald J. Wides** received his Ph.D. in molecular biology and genetics from Johns Hopkins in May 1986. He received a Fulbright fellowship and a Weizmann fellowship to do post-doctoral work at the Weizman. He, his wife Ellen Sharkman, and his daughter Leora left for Israel in July. . . . **Anthony Jose Clark** received his

M.D. from Jefferson Medical College in Philadelphia in June. He is now beginning a residency in general surgery at New Britain (Conn.) General Hospital. He and his wife Susan have a daughter, Rebecca. . . . **Barbara E. (Locke) Arnio** married Bruce Arnio during the summer of 1985 and is now expecting their first child. She also has an 8-year-old step-daughter. She's still working at Rogers Corp. with lots of other M.I.T. alumni and says hi to all Thord East friends. . . . Also recently married is **David W. Gravens**, who married Eva Apfelbaum (who is from Jerusalem and Warsaw) on January 4, 1986, at the Tarrytown Hilton in New York. **Barry Cinnamon** was his best man. He and Eva are now living in Dobbs Ferry, N.Y., and he's still working for Citibank on Wall Street, where he's responsible for investigating and developing artificial intelligence applications.

Lawrence Cater is an applications engineer for Rexnord Automation—Control Systems Division (formerly E.M.C. Controls). His main emphasis is on process software—he's developing structured methods for analysis, design and implementation. **Jean Fischar** joined Rexnord about the same time he did, a year and a half ago. . . . **Joan Solomon** is now an officer with the communications division at First Chicago in the New York regional office. She recently became the proud owner of a Manhattan co-op apartment and appeared in the New York *Post* in a publicity stunt for a show she starred in at St. Barts Playhouse.

Don't forget to write, everyone!—**Kate Mulroney**, Secretary, Index Systems, Inc., Five Cambridge Center, Cambridge, MA 02142

81

Hello everybody, and Happy New Year! Wouldn't it be great to start off the new year with a long column filled with exciting news of our classmates? It certainly would be. However, it is impossible because only **Andy Ubel** has written this month. But don't despair: We can all make New Year's resolutions to write to our class secretary and let us all know what we are up to. Andy was married to Margaret Johnson (Stanford '83) on August 23. In attendance were **Jeff Olson**, **Brad Pines**, **Bob Clarke**, **Paul Marcus**, **Bill Fowler**, and Pete Steinhagen, '79. Congratulations!

Please write!—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

83

I guess most of us probably just get the standard day or two at Christmas and New Year's. Remember the days of IAP? It would be nice to take a 6-week break about now and go skiing or travel around.

Our first item is from **James Shearer**. James is currently employed by Boeing Aerospace and living in Kent, Wash. James has the company of Lori Bechtold, '84, **Chris Dunmire**, and **James Roberts** at Boeing Aerospace. **Denise Brush Roberts** is also in Kent with the group—she married James Roberts but chose not to work at Boeing Aerospace because of materimonial ties; she works for Boeing Commercial Airplane Co. We also have a letter from Lori Bechtold with more news from the state of Washington: The letter is entitled "What is happening in Seattle." Chris Dunmire planned to marry Patty Coppin on September 13. Chris decided that the only person who could possibly be his best man was James Shearer. The matron of honor was to be Lori Bechtold. And no wedding in Seattle would be complete without the appearance of James and Denise Brush Roberts. For the honeymoon, Chris and Patty planned to drive a jeep down the coast to L.A. along the very scenic route, maybe stopping in Las Vegas.

Masao Ishihama wrote in a brief note that he is currently in research and development in the field of noise and vibration control of automotive power plants. . . . Congratulations to Monica and **Steve Isakowitz** who planned to tie the knot on September 20 in Miami Beach, Fla. Pooter, Shimbo, Craigmile, Garyo, E.J., Sideways, Borja, Kowtko, Martin, and Ruby extend their best wishes and luck to the couple. . . . **Martin Kannengieser**, formerly of Shearson Lehman, now works with Drexel Burnham and Lambert. Martin writes that his wife-to-be will be studying at the Sorbonne in Paris. He already has planned five trips to meet her in Europe.

We have a Celebrity '83 update. **Jeffrey Harris**, former Celebrity '83, sent in a thank you note for his selection. In case you have forgotten, Jeffrey donated a rather large sum of money to M.I.T. Jeffrey says that donating the money was just something that he has always wanted to do. Since being selected as Celebrity '83, Jeffrey's life has changed: Because of his Celebrity status, Purdue University's aeronautical master's program accepted him as a degree candidate. Jeffrey of course accepted this offer. Jeffrey spent most of the summer in Europe, where he co-authored a paper which was selected at the NATO conference in Hague, Netherlands, where he presented it. Jeffrey found time to visit Germany, Austria, Italy, France, Switzerland, and England. One of the trip's highlights was being trapped in a gondola with five Italian women. What can we say about a guy who used to wear his hair in a crewcut, who dressed in polyester doubleknit pants and dress shirts and who spent a lot of time tooling, but who now has hair which continually threatens to violate Air Force regulations, and now wears cords, Oxfords, other cotton shirts—and even dabbles a bit in poetry? He's come a long way.

Our Celebrity '83 for this issue is none other than **Al Bashawaty**. After being at Morgan Guarantee Trust for only one year, Al has been promoted to assistant treasurer and officer in the Morgan Far West Banking Division. Not only was Al the first one in his training program to get promoted but he is currently the youngest officer in the 150-year history of Morgan Guarantee. Al says that he is still underpaid and still has a nasty slice on the golf course. I am confident that he will be able to get both of them under control.

As for myself, I have been keeping busy. I started coaching Munchkin football—I have 10-year-olds in the tackle little league division. That has been a lot of fun. I had several visitors from Sweden recently. They were in New York for about three weeks. I sent them to Washington, D.C., where they stayed with Eric Gilbert, '84, and Mark Larow, '82. The pace in New York is as slow as ever. I have a feeling, though, that the pace might pick up one day. Well, keep the letters coming and enjoy the New Year.—**John E. De Rubeis**, Secretary, 14 Charles Ave., Port Washington, NY 11050

84

Happy New Year! I hope everyone had a good holiday (and since I am writing this in September, I hope I had a good holiday too). First off, I would like to congratulate **Janet Pesaturo** and Robert Zak, '85. They were married in September, and I flew to Boston to be in the wedding. Other members of the class of '84 at the wedding were **Liz Bashoff**, who is now in her third year at SUNY Stony Brook medical school, and **Janet Schnee**, who finished her second year at Dartmouth medical school and is now working in a lab at Massachusetts General. Janet P., who finished her second year at Albany medical school, is going to be working at Brigham and Woman's Hospital in Boston for a year. . . . Since we are on the subject of weddings: I also attended the wedding of **Janice Park** and Jong-Eup Kim (from Stanford) in August. She is currently a third year medical student at Stanford. . . . **Wayne Greene** writes from Berkeley, "**Paul Gjording** has recently become engaged to Marion Kelly. Paul now works for a private environmental consulting firm furthering the death of the San Francisco Bay while Marion, a Berkeley graduate, between catering concerns, works for a law firm in S.F. Both are eager to escape east from the California Syndrome."

We still need everyone's help in writing letters to us about the activities of '84 classmates. Or else you can get information to us by letting the Alumni Association know, as these people did: **James Gottwald** and Margaret Kelly are engaged. . . . **John Einhorn** was selected to be the recipient of the 1985 William E. Jackson award. . . . **John Piotti** has been named the "first full-time administrator for the community advisory board of the Massachusetts Water Resources Authority." . . . **Seng-Tiong Ho** was awarded a 1986 Newport award for further research in laser and electo-optics technology and is continuing his studies for a Ph.D. at M.I.T. . . . **Alyssa Goodman** is a second-year Ph.D. fellowship. . . . **Charles Limoli** is involved with a start-up company called Electro Optic Company and it "is doing well!" (we hope it stays that way). . . . **Tanya Segel** has been "an urban planner at Skidmore, Owings, and Merrill, in Boston, for two years working on large-scale controversial projects such as 500 Boylston Street and the Fan Pier and Pier 4 Developments," but she is now at Wharton Business School.

That's it for now; have a great year and keep those letters coming (or at least start writing them). I hope all of you like the way we are now doing these columns (in a rotation between **Diane Peterson**, **Lisa Tener**, and myself). I think that it is a good way to get a more class wide column. We will be hearing from Diane next issue.—**Mona Wan**, Acting Secretary, 10480 Creston Dr., Los Altos, CA 94022

86

Howdy folks. This is the last column I'll be writing from Dale City, Va. In three weeks I'll be on my way to Los Angeles with hopes of becoming a California girl. I'll let ya'll know what my new address is as soon as I know it.

Tom Paterson and his wife Mirta are living in Springfield, Va. because Tom is working in Washington, D.C. . . . **Karl Tucker** is getting ready for school to start again, this time as a grad student in Course 16. (I know we've been out of it awhile, so I'll refresh your memories—that's Aero/Astro.)

Wally Santarelli, a fellow Aero/Astro, along with **Simone Pottenger** and **Karl Kowalski**, is working for Boeing up in Renton, Wash. (near Seattle). Wally's working in the Flight Systems group for the 767, and Simone and Karl are working on the "high-tech" 7J7. Wally says **Bill Herlan** will be working on arc-jet engines for NASA in Cleveland. Sounds great—maybe I'll see you guys in four years.

About two weeks ago, I took a road trip up to West Point to take in a football game. Well, I crashed a party in the City (New York City, that is) that **Karen Wohl** was giving. She's getting along quite well at Merrill Lynch. . . . **Ellen Epstein** was also there. She was visiting from Boston. . . . **Andy Chess**, **Jim Egan** , and **Bill Brennan** made the party, too. Jim's enjoying work at Turner and Andy and Bill are back in school (Andy at Columbia Med School and Bill at Fordham Law). . . . Karen mentioned that **Roderick Mason** worked for Shearson Lehman over the summer and was returning to M.I.T. for a master's in Course 15 (that's management).

I talked to **Greg Harrison** who will be traveling out to Los Angeles about the same time I am. He was working in Rhode Island over the summer, but he's pretty excited about moving out to California. I know how he feels!

Don't forget those regional parties coming up in June. Stay tuned next month for the class of '86 notes, same time, same place, same channel. Catch ya'll later.—**Mary E. Cox**, Secretary, 14317 N. Brook Dr., Dale City, VA 22193

I CIVIL ENGINEERING

Egor P. Popov, S.M.'34, shared the 1986 Raymond C. Reese Research Prize by the American Society of Civil Engineers for a paper (with James O. Malley, a San Francisco engineer) on "Shear Links in Eccentrically Braced Frames." Popov, professor in the Department of Civil Engineering at the University of California, Berkeley since 1946 and professor emeritus since 1983, has written two texts which are used in teaching engineering mechanics. Popov's work has involved analyses of structural shells, the inelastic behavior of steel and concrete structures, and the seismic response of buildings and seismic components. ASCE credits him with ". . . a major impact on building design in seismic areas and the design of offshore platforms and oil pipelines." . . . **Damian J. Kulash,** Ph.D.'71, has been selected executive director of the National Research Council's new five-year Strategic Highway Research Program (SHRP), a $150 million program funding research on asphalt and concrete pavement performance and maintenance, bridge component protection, and snow and ice control. Kulash has served as director of special projects for the Research Council's Transportation Research Board (since 1982).

II MECHANICAL ENGINEERING

Professor **James B. Matthews,** S.M.'59, dean of the College of Engineering and Applied Sciences at Western Michigan University, Kalamazoo, has been appointed to the Michigan Board of Professional Engineers. . . . **Arthur E. Bergles,** Ph.D.'62, has been named the John A. Clark and Edward T. Crossan Professor of Engineering at Rensselaer Polytechnic Institute, Troy, N.Y. Bergles was formerly distinguished professor of engineering and chairman of Department of Mechanical Engineering at Iowa State University. An active researcher in heat transfer, Bergles is also a governor of the American Society of Mechanical Engineers. . . . **James A. Moore,** Ph.D.'75, was recently appointed associate professor in the Department of Mechanical Engineering at the University of Lowell (Mass.). Moore formerly served as a senior research scientist for Cambridge Collaborative, Inc.

III MATERIALS SCIENCE AND ENGINEERING

William R. Prindle, Sc.D.'55, director of materials research at Corning Glass Works Research and Development Division, Corning, N.Y., has been named a fellow of the Society of Glass Technology. An authority on materials research, Prindle is also president of the International Commission on Glass, a nonprofit association promoting glass science and technology. . . . **William K. Goetz,** S.M.'63, has been named president and chief executive officer of Aavid Engineering, Inc., Laconia, N.Y. Formerly, Goetz held various product development, materials, marketing, and manufacturing management positions at Texas Instruments, Inc., Attleboro, Mass.

Craig D. Douglas, Sc.D.'83, has been promoted from assistant to associate professor in the Department of Mechanical Engineering at the University of Lowell, Mass. . . . **Eugene Meieran,** Sc.D.'63, of Intel Corp., Palo Alto, now has the title Intel Fellow. Professor **Merton C. Flemings,** department head at M.I.T., decribes this as "a unique position—Gene is the only one at Intel, and only the second in Intel's history." In addition, Meieran was honored by Purdue University, his undergraduate school, by being chosen one of their seven Distinguished Engineering Alumni earlier this year.

James C. Fulton, Sc.D.'53, assistant to the vice-president and technical director of the Allegheny Lundlum Steel Corp., passed away on August 29, 1986. In addition to 24 years at Allegheny Ludlum, Fulton spent six years at the Department of Energy, Washington, D.C., as a program manager in charge of energy conservation for the iron and steel industry. He was prominent in several professional societies including the Iron and Steel Society; the Metallurgical Society of AIME (serving as a director from 1973 to 1975 and president in 1974); and the American Society for Metals, of which he was made a fellow in 1974.

IV ARCHITECTURE

Anne Middleton Wagner, assistant professor of the history of art at M.I.T., is the author of *Jean-Baptist Carpeaux: Sculpture of the Second Empire* (Yale University Press, 1986). It's described by Richard Dorment in the *London Times Literary Supplement* as "a genuinely original book, one of those rare works of art history that change the way we view not just the artist under discussion but the art of the period." Wagner will teach a new subject at M.I.T. this spring: "Virgin, Harlot, Hysteric: Visual Imagery of Women in the 19th Century Culture."

The environmental impact assessment process is itself assessed in a special issue of *Environmental Impact Assessment Review* (June 1986), of which **Lisa A. Berzok,** M.C.P.'85, of Parsons, Brinkerhoff, Quade, and Douglas, New York, was guest editor. The *Review*'s senior editor is Professor **Lawrence Susskind,** Ph.D.'73, of M.I.T. and its editor, Therese Hill, maintains offices in the Laboratory of Architecture and Planning at M.I.T.

Professor **K. Michael Hays,** M.A.A.'79, of Princeton is the editor of *Assemblage*, subtitled "A Critical Journal of Architecture and Design Culture," the first issue of which appeared last October under the imprint of the M.I.T. Press. Among the members of the magazine's Advisory Board is Professor **Stanford Anderson** of M.I.T. . . . Dean **John de Monchaux** of M.I.T. was chairman of the awards jury for the annual awards for design excellence sponsored by the New England Regional Council of the AIA.

George L. Claflen, Jr., '69, associate professor of architecture at Temple University, Philadelphia, has been reappointed chairman of the department for a second three-year term. Claflen, a member of the Temple faculty since 1974, also owns Claflen Associates, Architects and Planners, and since 1980 has been consultant on educational facilities for the Navajo and Papago tribes through the nonprofit Association on American Indian Affairs. This involvement led Claflen to build an elementary school for the Indians on the Black Mesa reservation in Arizona, thus allowing the children to live at home while going to school. Before the construction they were sent away to boarding schools. . . . **Stanley Ira Hallet,** M.Arch.'67, former professor of architecture at the University of Utah, has been appointed associate dean of the Catholic University of America's School of Engineering and Architecture and chair of its Department of Architecture and Planning, Washington, D.C. Hallet, an expert in Islamic architecture, plans to expand the department to make Catholic University "the future clearinghouse for innovative ideas and research on religious architecture and alternative uses of religious buildings." . . . Professor **Nicholas P. Negroponte,** M.Arch.'66, in the department at M.I.T. has been appointed a director of the Computervision Corp., Bedford, Mass.

V CHEMISTRY

Harbo P. Jensen, Ph.D.'74, who is with the Standard Oil Co. of California in San Francisco, was honored last fall with the Alumni Association's **Harold E. Lobdell,** '17, Award; he was cited for service as a "key volunteer" in the San Francisco area, providing strong support through the M.I.T. Club of Northern California and the Alumni Fund.

Advances in electrochemistry were reviewed by **Mark S. Wrighton,** Frederick G. Keyes Professor of Chemistry at M.I.T., as a panelist in the 30th annual Welch Foundation Conference on Chemical Research in Houston last November. Also on the program: **J. Ross Macdonald,** '44, formerly vice-president of Texas Instruments, Inc., who is now Kenan Professor of Physics at the University of North Carolina.

Robert C. Breckenridge, Ph.D.'42, physicist and former director of physics research for North American Rockwell, Canoga Park, Calif., passed away on September 5, 1986. Some of Breckenridge's career highlights: served as a research associate and assistant professor at M.I.T. until 1948; was in turn director of the Union Carbide Corp. Research Institute and Parma Research Laboratory; served as chief of solid state physics for the National Bureau of Standards; and head of physics branch of the Office of Naval Research; and joined North American Rockwell in 1964. Ill health forced his early retirement in 1973. Breckenridge was a fellow of the American Physical Society, a member of the American Chemical Society, and a founding life member of the M.I.T. Sustaining Fellows.

P. Hagelstein

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Seng-Tiong Ho, '83, who's working as a doctoral candidate with Professor **Jeffrey H. Shapiro,** '67, on the exploitation of squeezed-state light to improve advanced communication systems, now holds a 1986 Newport Research Award of $12,000. The grant, one of four given nationwide in 1986, is provided by Newport Corp. and administered by the Optical Society of America.

William W. Wu, S.M.'67, a senior member of the technical staff at INTELSAT, is the author of a two-volume text, *Elements of Digital Satellite Communication* (Computer Science Press, 1986), designed for graduate students and for use as a reference source. Wu is a part-time faculty member at George Washington University, and he's been chairman of the IEEE Information Theory Group of Washington, D.C.

Among participants on "Frontiers of High Technology," a production of the Learning Channel under sponsorship of IEEE: **Donald J. Atwood,** S.M.'50, president of GM Hughes Electronics Corp. The production is described as "a two-hour cable TV learning experience focusing on the impact and pervasiveness of high technology on man and his environment." Atwood will become executive vice-president of General Motors and a member of its Board of Directors on January 1.

President Emeritus **Jerome B. Wiesner** was honored late in 1986 with the C & C Prize—the initials stand for computers and communications—sponsored by the Nippon Electric Co. through its Foundation for C & C Promotions. Wiesner was honored for contributions "to the development, growth, and establishment of the field of computer science and media technology."

Gerald G. Probst, S.M.'56, recently retired as chairman of the Sperry Corp., New York City, but continues to serve as director and special consultant. . . . **Norman Wittels,** Ph.D.'75, has been appointed associate professor of electrical engineering at Worcester Polytechnic Institute (Mass.). Wittles most recently served as an engineering consultant, specializing in industrial machine vision and robotics.

Peter Hagelstein, Ph.D.'81, physicist who is described as the "reluctant" inventor of a nuclear x-ray laser "that helped inspire President Reagan's 'star wars' program," has left his 11-year post at the Lawrence Livermore Laboratory to join the Electrical Engineering Department at M.I.T. as associate professor. Hagelstein's "defection" from "star wars" attracted considerable media attention; a *Boston Globe* article reported that Hagelstein's "associates said he had never been comfortable with weapons work." Following his resignation, Hagelstein told *The Tech* he was offered positions at various schools and labs, but "wanted to go to M.I.T.," he said. His research efforts while at M.I.T. will focus on "lasers using soft x-rays instead of the visible light commonly used now."

VI-A Internship Program

With the first eight weeks of the Fall '86 Term over as this is being written, most of our 276 VI-A students are back on campus following successful summer assignments, and 86.5 percent of them applied for Graduate School admission. With the first cut of admissions made, I'm happy to report that 68.8 percent of this group (53 students) has been granted admission (S.M. only). There will be additional admits following the January second look at all applications. A continued excellent showing!

As a tribute, and in memory of Professor Emeritus **Karl L. Wildes,** '22, who died April 30, 1986, at age 90, a memorial organ concert was held in the M.I.T. Chapel September 24, 1986. Performing artist was James David Christie, Institute organist and organist of the Boston Symphony, a friend of Director John A. Tucker's. Karl was from 1926 to 1942 assistant to VI-A's second director, Professor William F. Timbie. Professor Wildes had a great affection for VI-A and its goals and was a wonderful mentor, over the years, to the present director. Karl was also a serious student of the organ. He had visited many of the cathedral organs of Europe, he had a small instrument in his Memorial Drive apartment, and he had played the carillon in the Hoover Tower at Stanford University. A number of longtime friends and associates attended the Memorial Concert.

On September 19, 1986, Codex Corp. (subsidiary of Motorola, Inc.) held an open house as part of the opening of its new "Maresfield" headquarters in Canton, Mass. It is an exquisitely designed building complex in the shadow of Great Blue Hill, adjacent to Route 128, on what was a horse breeding and racing farm in New England's earlier days. **Kevin O'Toole,** '57, his wife, and I were guests at this gala affair. I had the pleasure, there, of meeting **G. David Forney, Jr.,** Sc.D.'65, and his wife, and we discussed the VI-A Program at Codex. Professor **Robert G. Gallager,** Sc.D.'60, serves as Codex's VI-A faculty adviser.

Since the last issue of these "notes" we've received much interesting correspondence and more than usual visitations from VI-A alum's. Briefly, and in alphabetical order, these are:

Jerome L. Abulafia (formerly Abel), '58, stopped by to tell us of his recent marriage. He is living in Millis, Mass. . . . **David M. Alpern,** '83, visited the office. He's with IBM's Research Division in their new Almaden Laboratory, just outside of San Jose. . . . **Allen J. Baum** '74, swung by M.I.T. from Providence, R.I., where he had attended a fantasy writers' meeting. Allen joined Apple Computer, Inc., Cupertino, Calif., last March. . . . **Richard W. Chin,** '81, was on campus handling recruiting for the Hewlett-Packard Co. He's currently in Santa Clara.

A nice long letter came from **David K. Gerber,** '84, saying he completed his pilot training and was first in his class of 50. Being at the head of his class allowed him to pick his next assignment and he has selected Bitburg Air Base in Germany, where he'll fly F-15's starting next February. Hooray! Our own "top gun." His current address is: PSC Box 1862, Williams AFB, AZ 85240-1862.

An old friend of mine stopped by from Stanford University where he is professor of electrical engineering and director of the Information Systems Laboratory. **Robert M. Gray,** S.M.'64, came to M.I.T. to present a paper and we had a pleasant half-hour visit.

Late one afternoon **Michael M. How,** '84, and **Atul Jain,** '85, came by to tell me they had started a new company named Tech Hackers, Inc., of College Point, N.Y. They had been talking to one of our VI-A's still on campus, **Neils Lauritzen,** '85, who joined us in the office.

Michael A. Isnardi, '82, received his Ph.D. from M.I.T. last June. He wrote us about an extensive 17,000-mile, 8 1/2-week trip around the U.S.A. taken this summer. After recovering for a week he started work at RCA Laboratories, Princeton, N.J. We hope we'll see some of his slides (over 1,000, he says) sometime!

We see **Ondria G. Jaffe,** '85, around quite often. She was recently married and her new name is **Ondria G. Wasem.**

In Boston for a meeting at the World Trade Center, **Steven K. Ladd,** '81, came by to tell us he

PHOTO: ISAAC L. CHUANG

has changed jobs and is now with the Microelectronics Division of Raychem in Menlo Park, Calif.

A letter came from **Steven H. Lin, Jr.**, '85, telling us that this past fall he enrolled in Cal Tech's Ph.D. program. After finishing his Master's in February 1985 he stayed on with the Hewlett-Packard Co. in Palo Alto, Calif.

On campus recruiting for Raytheon was **Donald S. Mason,** '83, who commented that he's seeing how much more VI-A's have to offer an employer upon graduation. . . . Also in the M.I.T. Center for Career Services I met **Gary G. Matison,** '66. Gary is with Perkin-Elmer Co., for whom he was recruiting, and lives in Wilton, Conn.

A note in July from **Maxwell D. Millard,** '33, explained why he couldn't attend the VI-A West Coast picnic. He now lives on Cape Cod in the summer. He says he has "fond memories of my days in VI-A even though the course was truncated by the depression."

Lydia met **Peggy A. Pescatore,** '84, at The Coop one day. Peggy is still working at Motorola and is engaged to be married next April. . . . It is now Professor **Dennis L. Polla,** '79, of the Electrical Engineering Department at Yale University. It was from that department, in 1950, that I received a Master of Engineering degree; so we had quite a chat about "dear old Eli." Dennis received his Ph.D. from Berkeley, where he taught for two years. He will be associated with Yale's newly formed solid-state electronics facility.

We also learned that **Stephanie L. Schindler,** '85, and **Jeffrey B. Winner,** '85, are now engaged and expect to be married in September 1987. . . . Just back in this country from Paris, where's he's been working for the past six years, is **Eric D. Sherman,** '79. With a change in company ownership, Eric decided to return to the U.S. and look for a new position.

I also met **Kevin D. Stoddart,** '71, at the M.I.T. Career Services Office. He was here interviewing for his company: Watkins-Johnson, where he is now manager of the Receiver Department in San Jose, Calif.

Professor **David F. Tuttle, Jr.,** '37, of Stanford was in the East combining some business with attending the aforementioned memorial organ concert in memory of Professor **Wildes**. . . . Another office visitor was Lieutenant **William J. Urschel,** '83, who was in town for the wedding of **Raymond C. McDowell,** '86. Will enjoys his work on digital flight control systems at Wright Patterson Air Force Base in Dayton, Ohio.

We've enjoyed all these letters and visitations—keep them up!—John A. Tucker, Director, VI-A Internship Program, M.I.T., Rm. 38-473, Cambridge, MA 02139

XIII OCEAN ENGINEERING

Norman K. Berge, N.E.'60, has been elected vice-president and treasurer of Bath Lumber Co., Bath, Me. Formerly, Berge was director of the Bath office of John J. McMullen Associates. . . . **James C. Card,** S.M.'70, graduated (last September) from the National War College, National Defense University, Fort Lesley J. McNair, D.C., where he majored in the study of resource management. Card holds the rank of captain in the U.S. Coast Guard.

Hubert B. Reece, '41, a retired U.S. Navy captain, passed away in Langley, Wash., on April 16, 1986; no further details are available.

XIV ECONOMICS

"Taking in each other's laundry" is by no means an appropriate value judgment of the service sector, says **Lynn E. Browne,** Ph.D.'80, vice-president and economist at the Federal Reserve Bank of Boston. Economic expansion of services "supports and is supported by growth in other sectors," writes Browne in the *New England Economic Review*. "Economic success is measured by the ability of the economy to provide a rising standard of living, not by the shares of employment in individual sectors."

John K. Castle, '63, of New York City, surprised the New York financial community last fall by resigning as chief executive of Donaldson, Lufkin and Jenrette Securities Corp., after 21 years of service. Castle left to form his own firm, which specializes in venture capital, leveraged buyouts, and other specialized equity investments.

George A. Hay, Ph.D.'56, on the faculty of Reed College, Portland, Ore., for nearly 30 years and acting president for one year, passed away on July 26, 1986. During his career Hay held several positions at the College, beginning as a member of the faculty in economics (1956), then becoming director of admissions and assistant professor of economics, vice-president and treasurer, executive vice-president, acting president, and special assistant to the president. During the 1960s and 1970s, Hay was involved with universities and international agencies in Nigeria, Kenya, Peru, and Indonesia, and (in 1978-79) was a visiting fellow and consultant for the International Institute for Educational Planning of UNESCO in Paris. Hay is also credited with a major role as chairman of the "Hay Committee," which helped Reed College overcome a financial crisis and balance its budget in the late 1960s.

XV MANAGEMENT

Frode Nordhoy, S.M.'62, is founder and chief executive officer of Strategic Analysis, Inc. (SAI), Reading, Penn. SAI, an international consulting firm with offices also in Brussels and Tokyo, specializes in market research and strategic analyses for the chemicals, biotechnology, electronics, minerals, specialty metals, and plastics industries. . . . **Patrick E. Casey,** S.M.'84, has joined Imaging Technology, Inc., Woburn, Mass., as manager of product marketing. Casey was formerly a strategic analyst at the Digital Signal Processing Division of Analog Devices, Norwood, Mass. . . . **John G. Fallon,** S.M.'69, has been promoted to head Shaemut Corp.'s Information Services Division; formerly he served as a senior vice-president of corporate planning.

Walter W. Schroeder III, S.M.'75, has been elected president of MidCon Corp.'s MidCon Marketing Unit, Lombard, Ill. Schroeder joined the firm in 1982, serving most recently as vice-president of marketing. . . . **Richard Grueter,** S.M.'78, has been named senior manager of Price Waterhouse, Boston, which specializes in providing audit services to businesses, financial institutions, and manufacturing concerns. Grueter joined the firm in 1978. . . . **Lance Heiko,** S.M.'75, has left his teaching position at Babson College to join the Department of Management at Bryant College, Smithfield, R.I., as associate professor. . . . **Jerome M. Gruber,** S.M.'79, has been promoted to general manager for the Gray Division of Parker Hannifin Corp.'s Nichols Group, Cleveland, where he is responsible for complete management of the division. Gruber formerly held positions as plant and marketing manager.

Sloan Fellows

Thomas G. Frost, S.M.'77, has been elected vice-president—coal sales at CSC Transportation, Baltimore, Md. Prior to this appointment, Frost served as vice-president—coal procurement for American Electric Power Service Corp., Lancaster, Ohio. . . . **Guy W. Nichols,** S.M.'61, is a director of Noble Affiliates, Inc., Ardmore, Okla.; he retired recently as chairman and chief executive officer of New England Electric System.

Senior Executives

James R. Sylla, '77, president of Chevron USA, Inc., has increasing responsibilities following his election to the Executive Committee of the Chevron Corp., San Francisco, Calif. . . . **Edward J. Schlegel,** '65, has announced plans to retire (May 1987) from the posts of executive vice-president and director of Caterpillar Tractor Co., Peoria, Ill.

Paul S. Randazzo, '77, of Millington, N.J., passed away on May 15, 1985. At the time of his death, Randazzo was general manager—Central Department at Asarco, Inc., New York City; no further details are available.

A plaque expressing the thanks of his fellow-alumni and of the Sloan School came to Wendel W. Cook, S.M.'68, from Dean Abraham Siegel (right) last October 17. Cook was completing 12 years' service—the last three as president—on the board of governors of the Society of Sloan Fellows. Earlier last year Cook retired after a distinguished career in the management of Eastman Kodak Co.

Management of Technology Program

Peter Drummond, S.M.'85, was in Boston October 9 and 10 and took Jacalyn Walker-Sharp and Jane Morse to lunch. He was just finishing a three-week vacation in the U.S., beginning on the West Coast, and he had managed to catch up with several of his classmates. He loves his job with Lucas Industries and feels he's very well situated as his boss, with whom he gets along very well, is number three in the organization. (But, as Peter put it, "That *doesn't* mean I'm #4!") He also enjoys living in the West Midlands area of England. Peter managed to see a lot of the U.S. on his trip, including the Grand Tetons, Yellowstone Park, and Dallas/Ft. Worth, Tex. He had the following to report on his classmates:

Alan Drane's whole department at Combustion Engineering has been laid off. So Alan is job hunting and, as far as we know, he and Ruth would like to stay in Connecticut if possible, as Ruth has a position in Hartford. Peter talked with **John Hallal** on the phone while in Boston, but didn't have chance to see him. John sounded busy, as usual, Peter reported. . . . **Gene Huang** is working very hard and very long hours at Booz, Allen. . . . **Jim Ishikawa** has set his wedding date to Annemarie for May 22 and has been very busy making all the arrangements. He continues to work hard and enjoy his position as product manager at Wang. . . . **John Kindinger** is traveling a lot for Pickard, Lowe & Garrick, Newport Beach, Calif., since he continues to have many assignments back on the East Coast. He and his family are really enjoying living in California where Cindy has a teaching job.

Richard Norton really likes his job with PRC Engineering in Orange, Calif., and he and Karen

PHOTO: BRADFORD F. HERZOG

Secret for Survival in the 1990s: Be Both Predictable and Adaptable

After two years of the five-year Management in the 1990s project in the Sloan School, a central issue is beginning to emerge: it is the necessity for companies and their people to be flexible and adaptable, able to achieve "wholesale restructuring that requires changing the mindsets of people" in the face of rapid technological change. Organizations have to become more responsive and nimble—"more like a cat," says Sloan School Professor Thomas W. Malone.

But, replies Professor Edgar H. Schein, his studies of corporate cultures as part of the project suggest a serious "Catch-22": a measure of predictability, which is the opposite of flexibility, is also necessary if people are to understand each other and work well together. It is still to be determined, says Schein, whether there are some issues on which firms can safely standardize and others on which they must manage to remain flexible.

This first glimpse of results from the Management in the 1990s research program was given to the 1986 convocation of Sloan Fellows last fall with a strong word of caution from Professor Michael S. Scott Morton, the project director. There are as yet no real results; the problems are complex, and there remains "great diversity in what faculty and sponsors see as the critical issues," Scott Morton said.

Contradictions and Uncertainty

Two watershed changes in the business environment during the past decade prompted the major study, Scott Morton told the Sloan Fellows in setting the stage for the convocation reports:

☐ A decade of technological change has left minicomputers and microcomputers everywhere in the office, mainframes largely irrelevant. At the same time, new communications technology has been teamed with these small, flexible computers, with results more dramatic than could be predicted for either alone.

☐ The business environment is increasingly turbulent, the result of such factors as global competition, rapid technological change, and excess capacity in traditional industries.

Everyone agrees that these two issues interact to make the management of human resources a key problem. For example, said Scott Morton, consider how changes in engineering design have brought the automobile industry face-to-face with the need to redesign hundreds of jobs and the organizations that support them.

There's widespread agreement, too, says Scott Morton, that the Management in the 1990s program will succeed in two goals:

☐ It will yield valuable new insights on the impact of technological change on management.

☐ It will help the Sloan School prepare its future students for an era when technological change is certain to be faster.

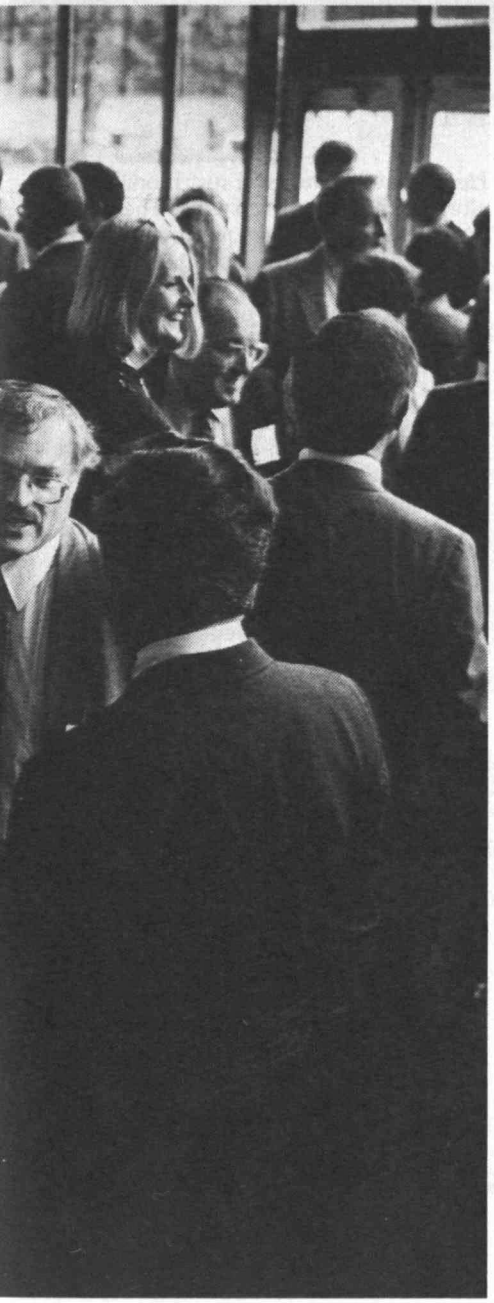
An example of contradictions in early results came from Professor Malone, who reported on studies of the effect of new information technology on organizational structure. One new information technology—the telephone—made possible the skyscraper, which is literally a vertical organization of its occupants. But now the new technology of electronic marketing is having just the opposite effect. Companies are linked together so effectively that vertical, hierarchial organizations may be obsolete.

An example of uncertainty from Robert B. Horton, S.M.'71, chairman and CEO of Standard Oil Co. of Ohio: everyone has heard how three-dimensional seismic systems that depend on sophisticated computers can improve the performance of prospecting and drilling for oil. But there are still plenty of dry holes. "Let no one forget that the machine is providing a model, not a promise."

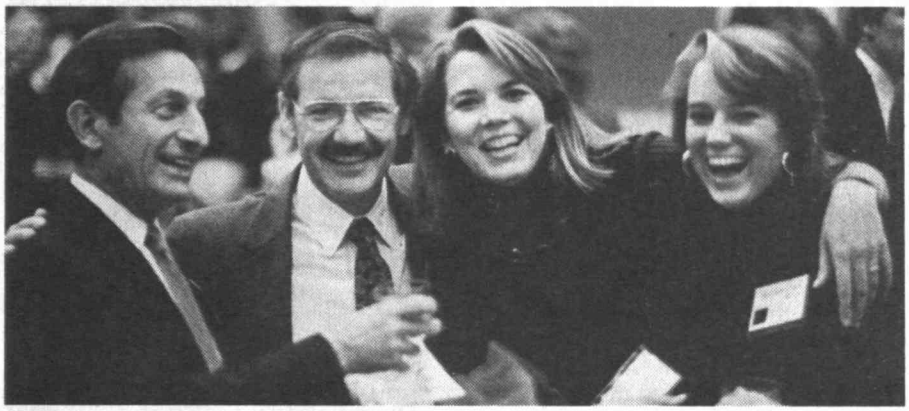
A Bond Firmed by Suffering

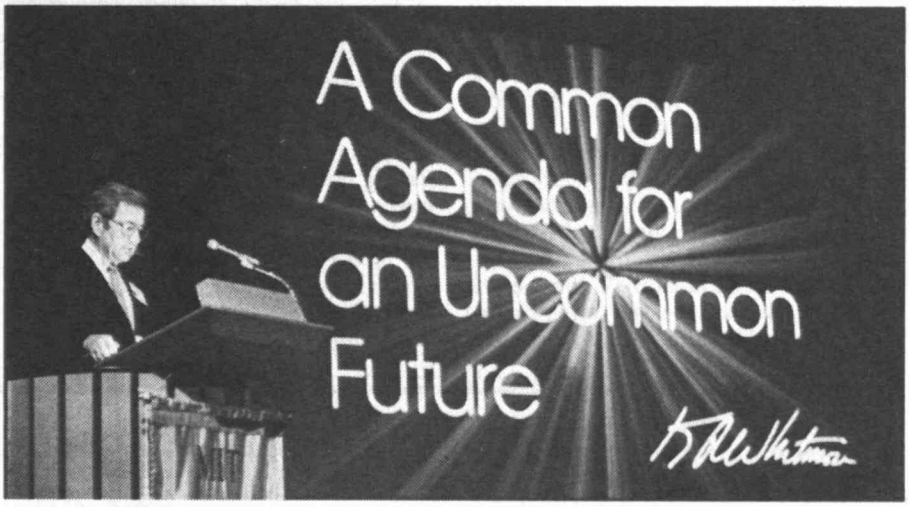
While professional issues took center stage, the convocation was also a chance for Sloan Fellows to enjoy the life long friendships grounded in shared ordeals of overpowering reading and writing assignments. Clearly, it's as President Gray, '54, said in greeting them: "One need not love a place less for having suffered in it."

Kay R. Whitmore, S.M.'75, president of Eastman Kodak, recalled his time at M.I.T. as "the best year of my life." Then Whitmore went on to deliver a stunning example of high-technology photographic visuals accompanying an important message. Among his observations: "Information is power," and it has traditionally been "the major source of authority for management." But now computer-based information is being developed by staff people at ever-lower levels, and middle management is



Like all college reunions, the triennial gatherings of the Sloan Fellows are the occasion for nostalgic rejoicing as well as professional renewal. As examples of the latter, the pictures at the bottom of this column show Kay R. Whitmore, S.M.'75, of Eastman Kodak concluding his breathtaking demonstration of high-technology graphics and Professor Lester C. Thurow delivering his primer on U.S. economic imperatives.





shrinking. "None of us will be unaffected" by this trend away from hierarchical toward flatter organizations, Whitmore predicted.

There was a special salute to the oldest Fellow present, Wren Gabel, '39. Gabel was an Eastman Kodak nominee to the original class that was assembled as an experiment with informal funding from Alfred P. Sloan, Jr., '95. And another special salute for Wendel W. Cook, S.M.'68, of Eastman Kodak, retiring after 12 years' service on the Board of Governors—the last three as president of the Society of Sloan Fellows. The new president: Robert Campbell, S.M.'78, president of Sun Refining and Marketing Co.—*John Mattill* □

PHOTOS: BRADFORD F. HERZOG

Advice to Parents on Nutrition

Spurred by a request from Children's Hospital in Boston, two staff members, Susan Sestini Baker, Ph.D.'82, a pediatrician, and a consultant in pediatric nutrition and Roberta Henry, director of food services, are authors of *Parents' Guide to Nutrition: Healthy Eating from Birth Through Adolescence* (Addison-Wesley). The book, a much-needed addition to the limited literature on nutrition for a growing child, conveys two related messages: childrens' eating needs differ greatly from those of adults; and their eating patterns for life are largely set by the model given by their parents during their formative years. "Children under six or seven are really captives of their home," Baker said ". . . and if nutritious foods aren't available, they will make other choices."

The book, easy to read and concisely written, dispels many nutritional misconceptions, answering questions such as whether honey is better than sugar for small children, whether parents should choose skim or whole milk for their infant, and whether the caffeine contained in soda is harmful. Other topics include the use of food as punishment and reward, fad diets, food allergies, and dealing with a picky eater. The fundamentals of good nutrition are also explained through tables and charts, a section on vitamins and minerals, and a discussion of the body's need for carbohydrates, fat, and protein.

At the end of the book, Baker and Henry have included a nutritional quiz along with in-depth answers. The questions are those most frequently asked by parents at Children's Hospital.

Susan Sestini Baker, Ph.D.'82 (left) and Roberta Henry (right), are authors of* Parents' Guide to Nutrition: Healthy Eating from Birth Through Adolescence, *a book to assist parents in making the proper nutritional choices for their growing child. Boston's Children's Hospital recognized the need for such a text, and it was at the hospital's request the team collaborated.

Baker is assistant professor of pediatrics and co-director of a new pediatric program specializing in gastrointestinal and nutrition development at the University of Massachusetts in Worcester, in addition to the work at Children's.

Her research focuses on the impact of brief periods of malnutrition on the gastrointestinal tract of the very young and on therapeutic measures to correct the resulting damage. "Unlike adults, children are growing and require a large amount of nutrients on a per pound basis to meet their needs for growth. Children who are deprived of necessary nutrients for short periods of time demonstrate significant changes in the structure and function of the gastrointestinal tract. These changes make it difficult for them to absorb adequate nutrients and a perpetuating cycle develops," says Baker.

Before receiving the Ph.D. in nutrition from M.I.T., Baker received an M.D. from Temple University School of Medicine (1972) and interned at Buffalo Children's Hospital. In 1975 she served as a medical officer in South Africa and Botswana. In 1984 and 1985 Baker received Hood Foundation Awards and a U.S. Department of Agriculture Nutrition Research Grant for her work at Boston Children's.—*Valerie Kiviat* □

are kept very busy with the two children. . . . The same story from Sallee and **Rick Orr**, who like living in the Dallas/Ft. Worth area. Their new baby keeps them on their toes, as well. . . . **Drew Peck** called in September and said he was on his way to England, Edinburgh, and Munich on business. He was back in time to catch Peter Drummond in the U.S. Peter reported Drew is excited about some very good potential opportunities coming up for him at Gartner. Liz is enjoying her move from catering back into editing.

In other alumni/ae news, **Rene Cormier,** S.M.'86, returned to the Geophysics Lab at Hanscom Air Force Base, Bedford, Mass., this summer where he is director of strategic planning. . . . **Bill Culbert,** S.M.'86, stopped by the office a couple of times over the summer. He has been seeking employment in the Boston and Orlando, Fla., areas. . . . **Ed Gilbert,** S.M.'86, reported in September it was quite a culture shock to get back to Carpenter Technology. The company has undergone many of changes, and the Technical Department was being reorganized. He said there was plenty of challenging work to be done, and he was enjoying getting back into the thick of things. . . . **Moises Goldman,** S.M.'84, popped into the office in October while at M.I.T. escorting a couple of Dukane vice-presidents. His main task at Dukane, as he put it, is to "create the R&D environment," and his department and responsibility continue to expand. Jane talked with **Jay Herther,** S.M.'86, in September: he was promoted to manager of INEWS concept Validation at Sanders Associates when a big joint contract with G.E. came through recently in integrated electronic warfare. Jay was hoping to hire six to seven "technical hot-shots." (He told an amusing story about how his building was picketed by an anti-nuclear group thinking "INEWS" stood for "nuclear." Someone straightened them out, so Jay could get back to work!)

Terry Leslie, S.M.'86, stopped by in October very briefly. He was here with a couple of IBM colleagues to visit with faculty concerning the chip manufacturing business. . . . **Ricardo Morchio,** S.M.'85, came by in October while here on business. He was very excited about his new company, called Profil S.A., based around a process he discovered that makes inferior wines into high quality. The company is really taking off now, and he has five or six M.I.T. colleagues working with him (out of a total company of 25). He's now working on a process to do the same thing for orange juice—a method to maintain its fresh taste for long periods of time. At the same time he continues to work for the Argentinian Navy a few hours a week. Ricardo was pleased to announce the birth of his new daughter, Carla, in June. His wife, Christine, has gone back to work as a lawyer in Buenos Aires. Ricardo hopes to return to Boston in January and bring his family with him.

Kim-Chinh Tran, S.M.'86, was in town in September. He visited with Jacalyn Walker-Sharp and reported he loves his work at Westinghouse. He buys and starts a lot of companies for them as a principal in technology acquisitions. On the personal investment side, he just bought himself a house in Texas.—Jane Morse, Program Manager, Management of Technology Program, M.I.T., Rm. E52-125, Cambridge, MA 02139

TECHNOLOGY AND POLICY PROGRAM

Steven Izatt, S.M.'84, is now working as a consultant in "New Business Development" for Touche, Ross, and Company, Philadelphia. . . . **Valerie Pietrzyk,** S.M.'85, completed her first year at Dartmouth Medical School and spent the summer working as a public health service officer, working in the FDA's Center for Devices and Radiological Health. . . . **Jon Zilber,** S.M.'83, is now director for Kessler Marketing Intelligence, San Francisco. John revisited M.I.T. in September to speak at the M.I.T. Symposium on Fibre Optics.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Rm. 1-138, Cambridge, MA 02139

Carl L. Svenson, 1897-1986

Carl L. Svenson, '19, professor emeritus of mechanical engineering who was associated with the Department of Mechanical Engineering for his entire professional life prior to retirement in 1962, died at his home in Milton, Mass., in July; he was 89.

Julius A. Stratton, '23, who was president of M.I.T. at the time of Professor Svenson's retirement, recalls him as a "splendid teacher with a profound understanding of the problems of students." He characterized Svenson's service to students and faculty colleagues as "expert, efficient, and humane."

Professor Svenson was a specialist in thermodynamics. He began his teaching career at M.I.T. after military service in World War I, and from 1951 until retirement he also taught in the Lowell Institute School. Professor Svenson was executive officer of the Committee on Academic Regulations (later the Committee on Academic Performance) for more than a decade, and for many years he was scheduling officer for his department.

Professor Svenson studied at both Harvard and M.I.T., receiving bachelor's degrees from both institutions and the master's degree from M.I.T. in 1920.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Rock L. Comstock, Sr., '12; August 23, 1986; Milford, N.H.
George T. Paine, '17; February 2, 1984; Carmel, Calif.
Mrs. Basil S. Warren, '17; January 16, 1986; Bridgewater, Mass.
Lawrence H. Allen, '20; August 28, 1986; Oswego, N.Y.
Robert E. Robillard, '20; June 8, 1986; Sarasota, Fla.
Arturo Ponce Canton, '22; August 22, 1985; Merida Yucatan, Mexico.
Robert L. Peterson, '27; October 22, 1985; Rio Piedras, P.R.
William A. Zisman, '27; July 21, 1986; Silver Spring, Md.
Walter A. Anderson, '28; July 25, 1986; North Reading, Mass.
Irving L. Cook, '28; December 13, 1985; Moretown, Vt.
Joseph Stanley, '30; May 6, 1986; River Forest, Ill.
David V. Buchanan, '31; October 16, 1986; Peterborough, N.H.
John F. Glynn, Jr., '31; March 6, 1986; Cambridge, Mass.
Augustyn T. Rynalski, '31; July 29, 1986; Manhasset, N.Y.
William H. Strain, '31; April 15, 1986; Loudonville, N.Y.
Russell W. Abbott, '32; September 9, 1986; St. Petersburg, Fla.
Jose B. Calvo, '33; August 27, 1986; Mexico 12, D.F., Mexico.
David M. Nason, '33; July 4, 1986; Houston, Tex.
Louis M. Gerson, '38; March 26, 1986; Middleboro, Mass.
Donald R. Erb, '40; September 8, 1986; Dover, Mass.
John H. Hollister, '40; 1981; Barrington, Ill.
Edwin B. Hooper, '40; September 12, 1986; Chevy Chase, Md.
Herbert C. Wohlers, '40; August 15, 1986; Brevard, N.C.
Robert G. Breckenridge, '42; September 5, 1986; Northridge, Calif.
Richard R. Hughes, '42; June 16, 1986; Madison, Wisc.
John J. Vozella, '45; September 16, 1986; Reading, Mass.
Robert J. Zaworski, '47; July 24, 1986; Corvallis, Ore.
Isadore Candeub, '48; July 23, 1986; Methuchen, N.J.
Frank P. Coy, '49; July 13, 1986; Weekapaug, R.I.
Minas Deranian, '49; July 25, 1986; Andover, Mass.
Fernando E. Blanc, '53; July 1, 1986; East Montpelier, Vt.
James C. Fulton, '53; August 29, 1986; Natrona Heights, Penn.
Coleman Bresee, '54; September 1986; Hillsborough, Calif.
George A. Hay, '56; July 26, 1986; Portland, Ore.
Mitchell J. Savin, '56; August 20, 1986; Bloomfield, Conn.
Percy L. Edwards, '76; August 16, 1986; Dorchester, Mass.
Mauricio M. Gaston, '81; September 1986; Jamaica Plain, Mass.
Randolph G. Wei, '87; October 5, 1986; Newton, Mass.

Gray on Divestment: Little Effect in South Africa, Harm to M.I.T.

President Paul E. Gray, '54, stands firm: he is unequivocally opposed to South African policies on apartheid and "appalled by what is happening" in that self-destructing society. But neither he nor the Executive Committee of the Corporation believe that removing from M.I.T.'s investment portfolio the shares in companies that now do business in South Africa is an effective expression of opposition to that nation's racial policies.

Responding to a question at the National Alumni Conference in Costa Mesa, Calif., last September, President Gray said he is convinced that divestment has little if any political force. "Expecting to make a difference through divestment is like pushing on a string," he said.

Later in the fall, in a letter responding to criticism of Institute divestment policy from the campus Coalition Against Apartheid, Gray elaborated on his view:

"There are two principal reasons why I believe divestment is inappropriate and inadvisable.

"First, while, for many people, divestment holds important symbolic value as a means of expressing abhorrence of apartheid, I believe it is ineffective as a means of influencing events.

"The argument for divestment appears to be based on two premises: (1) that divestment by shareholders will cause U.S. corporations that operate in South Africa to reconsider their presence there and to disinvest, and (2) that such disinvestment will bring pressure on the South African government to eliminate apartheid.

"To date, there seems to be no evidence that validates either of these premises. Very few of the corporations under discussion have a major stake in their South African operations; for most, those operations represent a small fraction of assets, sales, or revenues. . . . My conversations with the chief executives of several of these companies leave me convinced that divestment by M.I.T. will not, in any tangible way, influence their future course in South Africa. Further, disinvestment is likely to result in a transfer of assets to a South African or other foreign owner on fire-sale terms and to bring into the picture some alternative, non-U.S. suppliers. This has been the response to the U.S. sanctions of September 1985, and such changes have neither weakened the state nor strengthened the black majority.

"There is also the question of the impact that disinvestment, were it to occur, would have on the people, the social fabric, and the future of South Africa. . . . I call your attention to the opinion of Helen Suzman, a member of the South African Parliament since 1953 and a courageous and outspoken critic of apartheid, in the *New York Times Magazine* (August 3, 1986):

" *'While realizing that I lay myself open to the accusation of paternalism, I have to say that I have more respect for the American companies that have, so far anyway, remained in South Africa (and have set aside millions of dollars for the education, training and housing of their black employees) than for those that have left the country. The companies that have left have taken with them what influence they could have had inside South Africa, thereby abandoning desperate, jobless breadwinners in a country with no social security safety net, no dole and no food stamps.*

" *'The moral outrage and desire for punitive action is something I understand very well, but the reality that will come as a result of a grievously afflicted economy will not be seen by those living thousands of miles away. That reality, compounded by decades of unequal employment opportunities and oppression, is bleak beyond belief. True, many black South Africans say they approve of disinvestment and sanctions, despite the additional hardships they will endure as a result. They fall into four categories: those who have no jobs and nothing to lose; those who have jobs in 'sheltered' employment and will lose nothing; those who want everyone to lose everything (therefore, 'roll on the revolution'), and, finally, those who believe that the South African Government will crack at*

the first (or, at worst, second) sign of sanctions. The last category brings to mind a former British prime minister who predicted that it would take 'weeks rather than months' to bring down Ian Smith's Unilateral Declaration of Independence in Rhodesia. In the event, it took another 15 years and 30,000 dead.'

"I also have difficulty with divestment on the basis of the inconsistency and narrow focus of that position. Divestment obviously expresses a moral judgment on the activities of the target corporations. . . . And, as an expression of disapproval, it seems to me to have unavoidable concomitants that most advocates have so far ignored.

"Does not disapproval also require:
☐ No academic associations with the corporation (e.g., Industrial Liaison Program, student internships, research sponsorship)?
☐ No solicitation or acceptance of corporate gifts?
☐ No purchases of the products of the corporation?

"Is it logical that divestment, particularly if urged and undertaken as a symbolic statement of moral principle, be separated from these other considerations? . . . As president, I cannot see M.I.T. taking a stand to divest and then failing to follow up on the consequent actions that such a stand would dictate.

"A further inconsistency in the call for divestment is the failure to recognize that the focus on companies that operate in South Africa misses the largest part of American business involvement there. There are only about 150 U.S. corporations that are Sullivan Principles signatories and that have demonstrated a commitment to those principles. There are many, many more—perhaps an order of magnitude more—that trade with South Africa but do not operate there. It makes no sense to charge the small number of companies that have taken positive steps to support black South Africans with 'propping up a racist government,' while at the same time ignoring the activities of companies that do business there from a distance.

'My second reason for opposing divestment is that such a policy would not be in M.I.T.'s interests as an educational institution. The action of divestment is a political statement on an issue having no first-order connection to the activities of this academic institution. Expressions of institutional views on such political issues run the risk of exposing the university to political treatment of its own interests.

"There is also the issue of the possible effects on portfolio performance, risk, and return, and the legal constraints that apply to university trustees as fiduciaries. The Executive Committee, which holds responsibility for investment policy, takes these arguments seriously. . .

"The trustees of M.I.T. bear the full legal responsibility for the operation and policies of the Institute. They are accountable in these responsibilities not just to the students and not just to the faculty. They have a responsibility to be informed about issues affecting M.I.T. and, as part of being informed, to be aware of the views about those issues which are held within this campus community. But community referenda, votes taken elsewhere, or demands by any one group cannot and should not be substituted for their ultimate judgment as trustees. They discharge a public trust, and they are expected to act on the basis of their individual and collective judgments concerning what is appropriate—even what is best—for this university."

"In summary, I believe that M.I.T. should not divest because doing so would have little effect on the situation in South Africa (and that of the wrong sign) and because the local concomitants of divestment would harm the Institute.

"I should note that the Institute has made efforts to aid in the education of a small number of South African blacks. And we continue to seek ways in which our capacities as an academic institution can be made to serve the needs of blacks there." ☐

ALLAN J. GOTTLIEB

To Win Four Out of Seven, Must You Win the Fifth?

This being the first issue of another year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 8, and 7) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1986 yearly problem is in the "Solutions" section.

Last night the New York Mets won the World Series after losing the fifth game, a timely introduction to **A/S 4,** the solution to which appears below.

Finally, Mary Lindenberg writes that a friend visiting Hong Kong met an M.I.T. alumnus living there who reads *Puzzle Corner* and asked about her. Ms. Lindenberg would like to correspond with this alumnus but does not know his name. I will be happy to serve as a go-between.

Problems

Y1987. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 7 exactly once each and the operators $+$, $-$, $\times$ (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 8, and 7 are preferred. Parentheses may be used for grouping; they do not count as operators. A leading minus sign *does* count as an operator.

JAN 1. John Boynton wonders what is the minimum number of high card points needed by a bridge partnership in order to insure making a 7NT contract.

JAN 2. Phelps Meaker has a regular tetrahedron whose edges are L units in length. What is the value of L if the number of units of volume of the tetrahedron is equal to the sum of the number of units of length of all the edges?

JAN 3. Walter Nissen wants you to find the next term in the sequence 11, 2, 3, 41, 5, 61, 7, 83, . . .

JAN 4. Our final problem is from Howard Stern, who writes:
Your doctor gives you n tablets, which you keep in a bottle. Each day you are supposed to take one half a tablet. Your method for doing so is to shake the bottle until either a full tablet or a half tablet falls out (assume the full and half tablets have the property that the probability one falls out is the proportion of that type in the bottle). If a half tablet falls out you take it. If a full tablet falls out you break it in two, take one half and put the other half back in the bottle. If you keep track of the days that you break a tablet this will be a sequence of n numbers (always starting with a 1 since you only have full tablets when you start). Concentrate now on the **last** day you break a tablet. The earliest last day could be n and the last could be $2n-1$. All other days in between are possible and some occur more frequently than others. The question is: What is the average last day you break a tablet?

Speed Department

SD1. Our first quickie, from Jim Landau, is related to **Y1987**:
What is the largest number that can be created with the digits 1, 9, 8, and 7 and the operations of addition, subtraction, multiplication, and division? What is the smallest non-negative number?

SD 2. Phelps Meaker's watch tells the 7 days of the week and 31 dates. Each moves ahead every 24 hours. But the mechanism that allows correcting the date for months of 28, 29, and 30 days does not work. On February 28, 1986 the watch says 14. When will the date be in sync with the calendar? For how long?

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

Solutions

Y 1986. Use the digits 1,9,8, and 6 to form the integers from 1 to 100; the rules are the same as those given for **Y1987**, above.

The following solution is from George Aronson:

1. 1^{986}
2. $1 + (9-8)^6$
3. $9 \times 6/18$
4. $6 - 18/19$
5. $91 - 86$
6. $1^{98} \times 6$
7. $1^{98} + 6$
8. $9 - 1^{86}$
9. $1^{86 \times 9}$
10. $1^{86} + 9$
11. $(8 \times 9) - 61$
12. $81 - 69$
13. $96/8 + 1$
14. $98/(1 + 6)$
15. $96 - 81$
16. $16 \times (9 - 8)$
17. $19 - 8 + 6$
18. $9 \times 16/8$
19. $1 + 9 \times (8 - 6)$
20. $(1 + 9) \times (8 - 6)$
21. $19 + 8 - 6$
22. $196/8$
23. $91 - 68$
24. $1 + 9 + 8 + 6$
25. $1 + 8 \times (9 - 6)$
26. ——
27. $9 \times 18/6$
28. $89 - 61$
29. $8 \times 6 - 19$
30. ——
31. $8 \times (6 - 1) - 9$
32. $8 \times (1 + 9 - 6)$
33. $198 / 6$
34. ——
35. ——
36. $6^{(18/9)}$
37. $98 - 61$
38. $19 \times (8 - 6)$
39. $(8 \times 6) - 9^1$
40. $1 - 9 + (8 \times 6)$
41. ——
42. $(8 - 1^9) \times 6$
43. $91 - 6 \times 8$
44. $61 - 8 - 9$
45. $9 \times (6 - 1^8)$
46. $6 \times 9 \times 1 - 8$
47. $8 \times 6 - 1^9$
48. $1^9 \times 8 \times 6$
49. $68 - 19$
50. ——
51. $69 - 18$
52. $6 \times (1 + 9) - 8$
53. $9 \times (6 - 1) + 8$
54. $6 \times 81/9$
55. $9 \times (1 + 6) - 8$
56. $(9 \times 8) - 16$
57. $1 \times 9 + 8 \times 6$
58. $(1 + 9) + (8 \times 6)$
59. $68 - 9^1$
60. $68 + 1 - 9$
61. $61 \times (9 - 8)$
62. $62 + 9 - 8$
63. $(8 - 1^6) \times 9$
64. $(1 + 9 - 8)^6$
65. $8 \times (6 + 1) + 9$
66. $(19 - 8) \times 6$
67. $86 - 19$
68. $1^9 \times 68$
69. $1^9 + 68$
70. $(9 - 1) \times 8 + 6$
71. $9 \times 8 - 1^6$
72. $1^6 \times 9 \times 8$
73. $89 - 16$
74. $(1 + 9) \times 8 - 6$
75. $(1 + 8) \times 9 - 6$
76. $69 + 8 - 1$
77. $91 - 8 - 6$
78. $(1 \times 9 \times 8) + 6$
79. $1 + 9 \times 8 + 6$
80. $8 \times (1^6 + 9)$
81. $9^{16/8}$
82. $98 - 16$
83. $89 - 6^1$
84. $1 + 89 - 6$
85. $86 - 1^9$
86. $1^9 \times 86$
87. $1^9 + 86$
88. $89 - 1^6$
89. 89×1^6
90. $1^6 + 89$
91. $98 - 6 - 1$
92. $1 \times 98 - 6$
93. $1 + 98 - 6$
94. $86 + 9 - 1$
95. $1 \times (9 + 86)$
96. $1 + 9 + 86$
97. $98 - 1^6$
98. 98×1^6
99. $98 + 1^6$
100. $(1 + 9)^{8-6}$

Also solved by David Simen, Steve Feldman, Glen Rowsam, Randall Whitman, Harry Zaremba, Thomas Weiss, Joseph Feil, Peter Silvenberg, Richard Williams, Jim Rutledge, Jim Landau, Mark Johnson, Arthur Gelb, Alan Katzenstein, Avi Ornstein, R. Stephen Callaghan, Greg Spradlin, Eli Passow, W. Compton, A. Holt, and Allen Tracht.

A/S 1. What is of particular interest about the factors of the following numbers: 1271, 42477, 74989, 128929, 923521, 4424351, 4782969, 536215711, 2889101203, 98695877281, 424777960767, 1470848491213, 7532627125087, 7617609926757, 12893722612807, 17037029794091, 28917102427847, 170396299851737, 1703971665820979.

This computer-related problem was solved by Lawrence Bell, whose Z-100 PC has also calculated (so far) the first 2000 digits of π. Mr. Bell sent me his calculation with the suggestion that such digits have an affinity for the circular file. His solution to **A/S 1** follows.

To solve this problem, I first wrote a straightforward BASIC program to find the factors. This didn't work at all for the larger numbers because of round-off error. In my next program, each number to be factored was treated as an array with each digit being one array element. An algorithm equivalent to long division was used to operate on the array one digit at a time. For each number, an ordered list of its factors (from smallest to largest) recreates the digits of π, appropriately truncated.

π = 3.14159265358979323846.

1. $1271 = 31 \times 41$
2. $42477 = 3 \times 14159$
3. $74989 = 31 \times 41 \times 59$
4. $128929 = 31 \times 4159$
5. $923521 = 31^4$
6. $4424351 = 31 \times 41 \times 59^2$
7. $4782969 = 3^{14}$
8. $536215711 = 31 \times 4159^2$
9. $2889101203 = 31 \times 41 \times 59^2 \times 653$
10. $98695877281 = 314159^2$
11. $424777960767 = 3 \times 141592653589$
12. $1470848491213 = 31^4 \times 1592653$
13. $7532627125087 = 31 \times 41 \times 5926535897$
14. $7617609926757 = 3^{14} \times 1592653$
15. $12893722612807 = 31 \times 415926535897$
16. $17037029794091 = 31 \times 41 \times 59^2 \times 653 \times 5897$
17. $28917102427847 = 31 \times 41 \times 59^2 \times 6535897$
18. $170396299851735 = 31 \times 41 \times 59^2 \times 653 \times 58979$
19. $1703971665820979 = 31 \times 41 \times 59^2 \times 653 \times 5897934$

Mr. Bell submitted a computer program for this solution. Copies may be obtained from the editor.

Also solved by L.J. Upton, Steve Feldman, Harry Zaremba, Matthew Fountain, Roger Milkman, Richard Hess, Winslow Hartford, Jim Landau, M.J. Ralph, and the proposer, Walter Nissen.

A/S 2. Find the smallest positive number whose prime factorization consists of the nine digits 1 through 9 and then find the smallest positive number whose prime factorization consists of the ten digits 0 through 9.

I am reprinting Jim Landau's solution, which presents a heurestic approach to attacking the problem. No solver supplied a *proof* of minimality.

To minimize the product of a set of primes consisting of the digits 1 through 9:

(a) 2 should appear as a single-digit prime. If 2 appears in the middle of a prime it takes up an entire decimal place, making the prime approximately 10 times as large as it could be.

(b) 5 should appear as a single-digit prime.

(c) Consider having 3 and 7 as single-digit primes. If 3 or 7 are needed as the last digit of multi-digit primes, try to keep 3 as a single-digit prime.

(d) 9 must be used to terminate a multi-digit prime.

Following (a), (b), (d) and the first sentence of (c), we find

$3,122,490 = 2 \times 3 \times 5 \times 7 \times 14869$

Can we do better? Yes, by going to the 2nd sentence of (c) we find

$2,992,890 = 2 \times 3 \times 5 \times 67 \times 1489$

This is the smallest product I could find. By similar reasoning, I find

$15,618,090 = 2 \times 3 \times 5 \times 487 \times 1069$

for the case with digits 0 through 9.

Also solved by Avi Ornstein, Winslow Hartford, Norman Spencer, M.J. Ralph, Harry Zaremba, Steve Feldman, Richard Hess, Michael Gennert, Matthew Fountain and Nob Yoshigahara.

A/S 3. Divide a two-inch cube into 8 slices with 7 equally spaced cuts. Find the ratio of exposed surface area to number of cuts. Now make 7 cuts in another plane, resulting in 64 little sticks. Again, find the ratio of total area to total number of cuts. Again make 7 cuts, resulting in 512 tiny cubes. The ratios all have similar repeating decimals. Do you dare make another series of cuts into the fourth dimension?

The following solution is from Richard Hess:

$s^1 = 8[4(1/4)2 + 2 \times 2^2]$

$R_1 = S_1/7 = 11.428571428$

$S_2 = 64[4(1/4)2 + 2(1/4)^2]$

$R_2 = S_2/14 = 9.714285714 \ldots$

$S_3 = 512(1/4)^2 \times 6 = 192$

$R_3 = 48/21 = 9.142857142 \ldots$

The editor believes that the suggestion of a fourth dimension was made with tongue in cheek. Several readers, however, carried out the calculation and found that there is no similar repeating decimal.

Also solved by Laurence Bell, Matthew Fountain, Winslow Hartford, Michael Gennert, Jim Landau, Yale Zussman, and the proposer, Phelps Meaker.

A/S 4. Given two evenly matched teams participat-

ing in a best-four-out-of-seven series, what is the probability that the team that wins the fifth game of the series will win the series?

Alan Ungar, clearly a baseball fan as well as a master of probability and statistics, submitted a fine solution that goes well beyond the stated problem: Let A represent the event in which the winner of the fifth game wins the championship, and B the event in which there is a fifth game. Then by the definition of conditional probability,

$P(A:B) = P(A \times B)/P(B) = P(A)/P(B)$,

where the last equation holds because A is a subset of B. The probability that there is a fifth game, P(B), is equal to the probability that neither team wins the first four games, or

$P(B) = 1 - 2(1/2)^4 = 7/8$.

The event A can occur in three mutually exclusive and exhaustive ways: the winner of the fifth game can win the championship in 5, 6, or 7 games (call these events A1, A2, and A3, respectively). Thus

$P(A) = P(A1) + P(A2) + P(A3)$.

Now, A1 occurs if the fifth game winner wins 3 out of the first 4 games; A2 occurs if it wins 2 out of the first 4, plus the sixth game; and A3 occurs if it wins 2 out of the first 4, loses the sixth, and wins the seventh, or if it wins 1 out of the first 4 and wins the sixth and the seventh. Since it is assumed that the teams are evenly matched, application of the binomial distribution with $p = 1/2$ yields the following values:

$P(A1) = 1/4$, $P(A2) = 3/16$, $P(A3) = 5/32$,

with their sum being 19/32. Thus, we have the result $P(A:B) = P(A)/P(B) = (19/32)/(7/8) = 19/28 = .679$. The empirical probability was 2/3, based on observation of 15 cases. The standard goodness-of-fit test using the chi square distribution with one degree of freedom does not reject the hypothesis that the observed frequency of .667 is significantly different from the theoretical value of .679, at a 95 percent level of confidence. In other words, it is not at all surprising that 10 out of the last 15 fifth-game winners won the championship. It should be noted that a similar analysis shows that the winner of the first, second, third, or fourth games of the series has probability of 21/32 of winning the championship, while the winner of the sixth game has probability of 3/4 of winning the championship. I analyzed the outcome of all the best-of-seven baseball World Series from 1905 through 1982 to see how closely these theoretical probabilities fit the data (Ungar's table is available on request to the *Review* in Cambridge). Although there seems to be a reasonably close match between the theoretical and observed probabilities, there are statistically significant differences which suggest that the assumptions of evenly matched teams and/or of independent Bernoulli trials do not hold. There are, for example, more four-game and seven-game series than one would expect. One possible explanation could be a psychological effect which, for example, saps the morale of teams that go down three games to none, and increases the probability that they lose the deciding fourth game. Indeed, 13 out of the 16 series in which a team lost the first three games ended in four games.

Also solved by Laurence Bell, Winslow Hartford, Jim Landau, Richard Hess, Matthew Fountain, Harry Zaremba, Steve Feldman, Ken Rosato, Peter Tzahnetos, Thomas Jabine, Maria-Elena Cheesman, Kelly Woods, Naomi Markovitz, Judy Badner, Chip Whiting, and the proposer, David De Leeuw.

A/S 5. A "right tetrahedron" has a vertex with three right angles. If a right tetrahedron, A,B,C denote the areas of the three faces that share the "right vertex" and D denotes the area of the face opposite the right vertex, show that $A^2 + B^2 + C^2 = D^2$ (a "Pythagorean Theorem" for areas in 3-space).

Let the length of the leg opposite face A be designated by a, the leg opposite the face B be designated by b, and the length of the leg opposite face C be designated by c. Hence the area of face A is (bc)/2, that of face B is (ac)/2, and that of face C is (ab)/2. Then:

$A^2 + B^2 + C^2 = (1/4)(a^2b^2 + a^2c^2 + b^2c^2)$. (1)

Let the length of the base of face A be designated by d, the base of face B be designated by e, and the length of the base of face C be designated by f. Area D, the face opposite the right vertex, is given by the following formula:

$D = (1/4)\sqrt{(d + e + f)(-d + e + f)(d - e + f)(d + e - f)}$. (2)

Squaring both side of (2) and multiplying the parenthetical expressions yields:

$D^2 = -d^4 - e^4 - f^4 + 2d^2e^2 + 2d^2f^2 + 2e^2f^2$. (3)

Since the vertices for faces A, B, and C are all right angles, it follows that

$d^2 = b^2 + c^2$; $e^2 = a^2 + c^2$; $f^2 = a^2 + b^2$. (4)

Substituting (4) into (3), obtain

$D^2 = (1/4)(a^2b^2 + a^2c^2 + b^2c^2)$. (5)

Comparing equations (1) and (5)

$A^2 + B^2 + C^2 = D^2$, as postulated.

Also solved by Naomi Markovitz, Harry Zaremba, Darrell Schmidt, Jerry Grossman and MACSYMA (a computer algebra system—ed.), Matthew Fountain, Ken Rosato, Richard Hess, Winslow Hartford, Jim Landau, Phelps Meaker, Howard Stern, M.J. Ralph, Mary Lindenberg, Jon Peltier, Ronald Goldman, and the proposer, Dennis White.

Better Late Than Never

1980 M/A 3. Harry Kamach and T.R. Keane have submitted a lengthy solution, copies of which may be obtained from the editor.

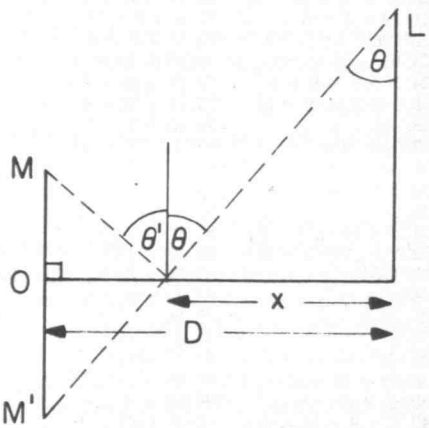
1985 N/D 1. Jim Landau believes that the only thing wrong with his "human friendly" solution is that the penultimate line should read ". . . the two line segments *from* the second set . . ."

1986 APR 1. Joseph Kesselman has responded and included an algorithm, which he attributes to Marc Donner, for calculating the phases of the moon.

Harry Zaremba, the proposer of the problem, noticed the following typographical error in the published solution. The letter S in the two string functions on line 20 should be replaced by the conventional dollar symbol. This applies also to lines 30, 60, 270, and 340 where the functions appear. In lines 40, 50, 70, 80, and 90, the commas should be shifted to the right so that they are located between the quotation marks. In line 100, the letter Y followed by a comma should be added to the right of the first semi-colon. The semi-colon between quotation marks in line 270 should be replaced by a comma. In line 410, the "greater than" symbol should be replaced by a "less than" symbol.

APR 4. Peter Silverberg has responded.

M/J 4. Martin Deutsch is not pleased with the published solution and writes:



The *image* of M is located at M' and does not move at all (unless the floor is suddenly tilted!). The point K is the intersection of the line of sight L-M' with the floor. We "note from physics" that $\theta = \theta'$. Physics does *not* say anything about the relationship between θ, x, and D. That is high school geometry, as is the following statement: Two triangles having the same values for two of their angles are similar triangles. Hence:

$x/(D - x) = 120/62$,

from which it follows that

$x/D = 120/182$.

This ratio holds for all values of D (even negative ones). Hence the change in x and D for any time interval is also in this ratio:

$\Delta x/\Delta D = 120/182$, and therefore

$R_x/R_D = 120/182 = 0.659$, and

$R_x = 0.695(42) = 24.692$

As a professor of physics at M.I.T., I may hold a distorted view of the mind of a typical reader of *Technology Review*. Still, I don't see how the introduction of irrelevant square roots and trigonometric functions makes the answer easier to grasp by anybody.

JUL 3. David Simen has responded.

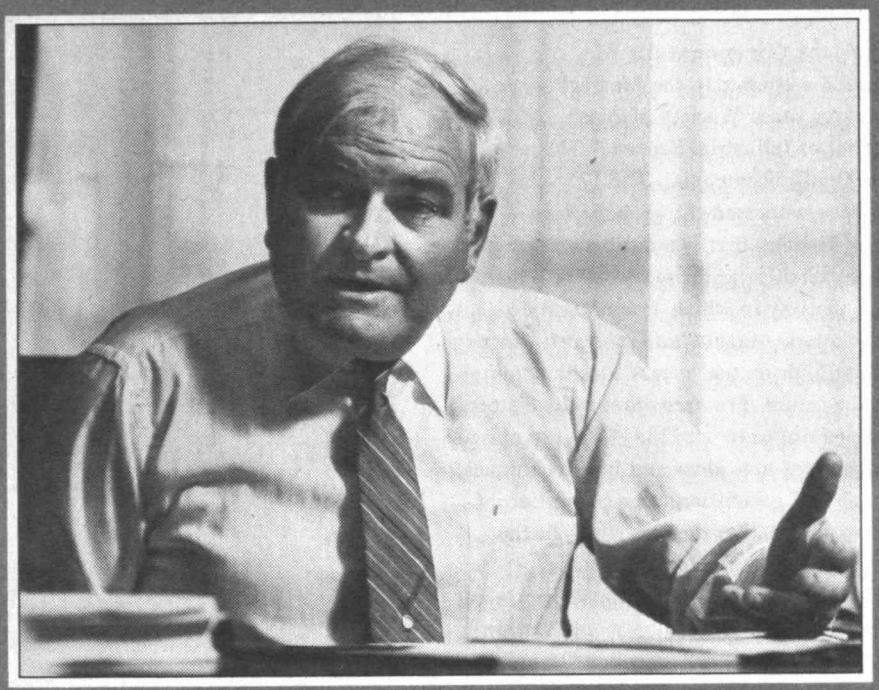
JUL SD 2. Robert Parry notes that the midpoint is actually *south* in the northern hemisphere.

A/S SD2. Kelly Woods notes that the sequence for part (a) can be extended to the left to begin 5, 10, 11, . . .

Proposers' Solutions to Speed Problems

SD 1. The largest number is 7^{891}, which is approximately 10^{1082}. The smallest non-negative number is $0 = (9 - 8 - 1) \times 7$.

SD 2. From 1 May 1988 through 30 June.



PAUL E. GRAY, '54, PRESIDENT OF MIT

REPORT OF THE PRESIDENT

FOR THE ACADEMIC YEAR 1985-86

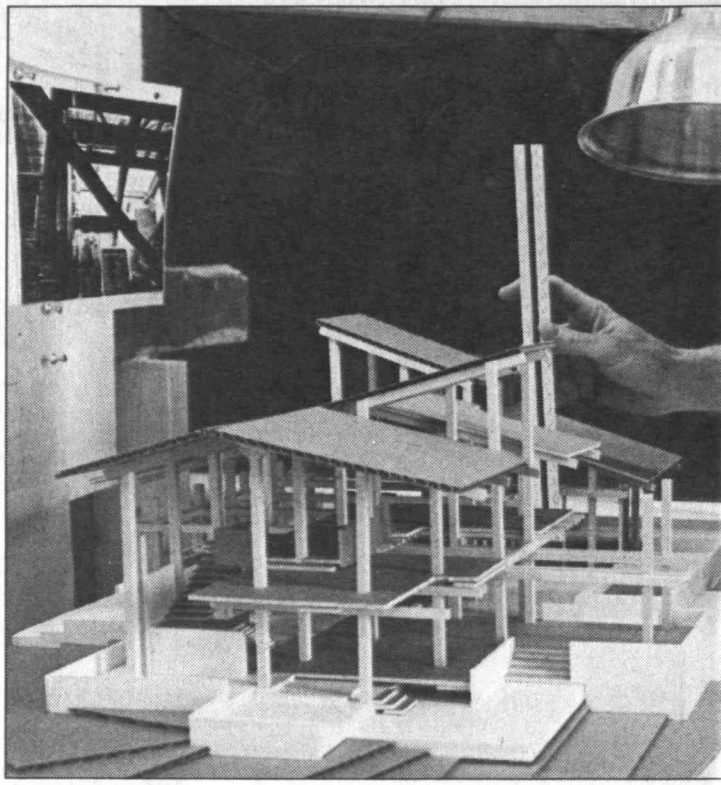
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

On April 10, 1861, the Commonwealth of Massachusetts granted a charter to the Massachusetts Institute of Technology for a "Society of Arts, a Museum of Arts, and a School of Industrial Science." This year, MIT celebrated its Quasquicentennial. The 125 years since its founding have witnessed the growth of an institution of higher learning that is unique, even among the great research universities of the world. MIT's special character resides in the way in which a community of senior and junior scholars—faculty and students—come together in a spirit of high mutual regard and uncommon zeal for inventing the future. For throughout our history, we have been involved not only with the discovery of new knowledge, the framing of new ideas and new techniques, but with the education of generation after generation of students in a manner that makes them partners in the process of discovery. Indeed, the idea for a "new education" as envisioned by William Barton Rogers—an education in which the lamps of learning would rest on a foundation of arts *and* sciences, and in which "learning by doing" would be a cardinal element—has created an ethos with few boundaries between the generations, between the disciplines, between the present and the future.

This ethos, this spirit, is kept fresh by the partnerships formed with the students who are drawn to MIT each year. For in so many ways it is the students who provide us with the capacity—and the imperative—for continuous self-renewal, comprising as they do a fountain of youth that keeps this place young and vigorous and committed to the idea of a future different from and far better than that which we have known.

This influence is so important that one of our highest priorities must always be the quality of the students who come here to study. The Institute has been blessed with students who are essentially without peer in their intellectual capacity, their commitment to personal achievement, and their motivation for lives of meaning and service. These young men and women draw, inspire, and fulfill the exceptional faculty who shape the educational and research programs of MIT. As one senior member of the faculty said at an orientation meeting for new faculty this fall: "However you teach them, they learn. They are the smartest people in America."

Without students of this caliber, MIT would not be the institution that it is. Strong, motivated students and an extraordinary faculty are the two sides of the coin of excellence. No university can, for very long, have one



without the other, and our future depends critically on our ability to attract the best students and provide for them educational programs of lasting value and relevance in a setting that encourages growth and personal development.

* * *

What are the issues most critical to our being able to draw the best students to MIT and provide the best possible education for them? And how would we define the best students and the best education for these times? This report will discuss these concerns and preview the steps we are taking to define a new academic program for undergraduates—one that will provide each student with the attitudes, habits of mind, and approaches to learning that will assure a lifetime of technical competence, social contribution, and personal fulfillment.

Students: Partners in Discovery

Our students tell us that they are attracted to MIT principally by our reputation for vigorous, high-quality academic programs in which they will have opportunities for substantial intellectual contact with the faculty. At both the undergraduate and graduate levels we have many more qualified applicants for admissions than can be accepted. Consequently, the admissions process focuses

Philip Thompson, a graduate student in Architecture, puts the finishing touches on his design project.

not on differentiating the qualified from the unqualified, but on selecting a subset of students from a larger group of applicants, all of whom are qualified to pursue studies here. The nature of the undergraduate admissions process is such that we have the opportunity to offer admission to a group of young men and women who encompass a wide range of interests and talents and who come from many kinds of social and cultural backgrounds. Our success in enrolling a class that embraces such intellectual and cultural richness is vital to the quality of education that we offer, both inside and outside the classroom. As I have said before, it is our responsibility to help students understand the many ways of seeing and understanding the world, so that they have full access to its opportunities, delights, and challenges. The culture created by the students, as well as the faculty, is a powerful determinant of how successful we are in meeting that responsibility.

An example of student influence on the educational climate is the effect of students' choice of major fields of study. As I have noted in previous reports, the last several years have seen a steady increase in students selecting a major in engineering, particularly in electrical engineering and computer science. This concentration of undergraduates in a single department and a single school creates severe difficulties for the school and for the Institute. For faculty in the department of Electrical Engineering and Computer Science, the burden of subject supervision, teaching, and advising and thesis supervision is numbing. The load mitigates against the preservation of a reasonable balance of effort involving undergraduate education, graduate education, and research. It also squeezes out the energy and time needed for intellectual self-renewal, curriculum development, and important new initiatives, such as the development of a program of lifelong cooperative education that would serve the needs of many practicing engineers. For several other departments, smaller numbers of undergraduate majors make the provision of a significant undergraduate program difficult and expensive, and are demoralizing for faculty and students alike. For the Institute as a whole, this concentration of interests in a few fields places an unspoken but powerful value on certain fields at the expense of others.

We have acted on this matter in a number of ways, beginning with consideration of the admissions process itself. This past year, the new Director of Admissions and his staff, working under the aegis of the faculty Committee on Undergraduate Admissions and Financial Aid, examined the criteria and the process for recruiting and selecting new students. Their review resulted in the adoption of an enhanced program to inform students about the range of opportunities for study at MIT, which led to an increase in applications, particularly from women. The Director of Admissions reports that the Class of 1990 displays a broader range of academic interests and, as always, comprises students who shine both inside and outside of the classroom. Over 95 percent of those who submitted class standings ranked in the top tenth of their high school classes, and 290 were valedictorians. Out of the freshman class of nearly 1,000, more than 180 had been class officers, nearly 400 had participated in varsity sports, and over 450 had held offices in school organizations. These students, of whom 38 percent are women and 10 percent are underrepresented minorities, came from throughout the country and around the world, bringing with them a richness of cultural background that is an education in itself for their peers.

The Admissions Office, working with the Admissions Committee, has also developed a modified selection procedure aimed at better identifying those students with the traditional strengths we have come to expect *and* the broader range of interests we seek. The new procedure, which will be inaugurated in the coming year, gives more attention to grades and the quality of a student's

PHOTO, PAGE 41, BY JIM HARRISON; ALL OTHER PHOTOS BY BRADFORD F. HERZOG

academic program as distinct from standardized testing, and seeks to better evaluate such qualities as love of learning, unusual brilliance, creativity, and leadership.

The diversity of students in this class, and among potential applicants, suggests that we will be able to admit classes that embody a broader range of academic and career interests. Our objective should be to create a better match between our students and the range of interests and talents found in our faculty. If we succeed, I believe we will be even more successful in creating a community of scholars, an intellectual and social environment, that is second to none.

* * *

A major factor in our ability to enroll the most desirable students has to do with the cost of an MIT education. As a science- and engineering-based university, our operating costs are high, and we must look to tuition to help meet those costs. It is not surprising that our tuition is among the highest in the nation. For several decades we have admitted undergraduate students on the basis of intellectual, not financial, capacity—and have provided financial assistance to those who are not able to meet the total cost of attending MIT. Our financial aid packages consist of scholarships and loans, and include the expectation that students will contribute earnings from employment during the summer. We also expect students to help meet their need through loans and/or part-time jobs during the academic year. This latter expectation is generally referred to as the "self-help" requirement.

The income from MIT's permanent endowment for scholarships provides only a fraction of the amount needed for undergraduate aid. During the 1970s and the early years of this decade, an inflationary economy caused costs at MIT and at other similar private universities to increase very rapidly. In spite of these cost increases, we have been able to maintain our policy of providing financial aid to all needy students, primarily by drawing on annual (unrestricted) funds to supplement the internal and external sources of financial aid available to our students. Between 1975 and 1985, this supplemental funding grew fourteen-fold, even though we were substantially increasing our expectations for self-help at the same time. While our use of unrestricted funds to support the financial aid program has remained relatively constant for the past few years, we have achieved this

state of precarious equilibrium in large part because of a slowdown in the inflation rate and by continuing to set very high self-help requirements. This year, we were able to hold the self-help expectation at the same level as last year, but at $4,900, it is the highest in the nation, and is about $1,000 per year greater than the average level at those private universities with which we compete for the strongest applicants.

During the past several years, the Federal aid programs upon which we depend so heavily have faced strong and recurrent efforts by the administration to shrink or eliminate them. Our ability to continue providing aid to all students with financial need will be threatened if Federal programs of student financial aid are further truncated or if there is a marked increase in the inflation rate. This is a very serious issue, for the nature of our financial aid policy has a great deal to do with the quality of students we can attract and with the quality of their educational experience while at MIT. As the Task Force on Undergraduate Financial Aid Policy noted in its report last year:

> "For approximately one-half of the undergraduate student body, MIT's financial aid policy is a crucial element in the implicit contract between them and

Professor Erich Ippen of the Department of Electrical Engineering and Computer Science discusses laser mechanisms with graduate student Janice Huxley.

the Institute. This policy directly affects the choice students have in selecting a college, the costs which they and their families will incur, and the level of indebtedness they will have after graduation. It indirectly affects the intellectual, economic, and racial diversity of each undergraduate class, the sense of pressure, and the degree of competition among students. It can exacerbate concerns on the part of students for financial stability. It can, and currently does, give students both the opportunity and the responsibility to choose their personal standard of living and the best balance between their academic work load and a term-time job. And, in a time of economic stringency, it can affect the choice of an academic major, especially when that choice is seen by the student as a vocational as well as an intellectual one."

Any departure from our current policy of admitting students on the basis of merit, without regard to need, is likely to impair seriously our capacity to enroll undergraduate classes of the academic quality and human diversity we have enjoyed in the past, classes that contribute so greatly to the intellectual and social vibrancy of this community.

Preservation of these policies requires, quite simply, that we have more funds available for undergraduate financial aid. MIT's scholarship endowment presently stands at about $113 million. An addition of $50 million to this endowment would greatly enhance our ability to meet fully the urgent requirements for scholarships; larger additions would obviously provide some cushion against future diminishment of Federal aid programs and some relief from pressures to increase the self-help level.

The situation with respect to financial assistance for graduate students is different in detail but similar in terms of its influence on our ability to continue to attract and enroll the most able students. For the most part, graduate students are independent of their parents—indeed, many are married with family responsibilities—and aid is awarded by MIT as well as outside agencies primarily on the basis of merit. Most graduate students in the Schools of Engineering and Science are supported as teaching assistants or with sponsored research funds as research assistants. But most graduate students in the Schools of Architecture and Planning, Humanities and Social Science, and Management are unable to find such forms of support because the volume of sponsored research activity in those Schools is relatively small. Many of these students rely on part-time employment at the Institute or elsewhere, a fortunate few have partial or full fellowship support, and a significant number find concerns about money for tuition and living costs a constant worry and a significant distraction.

Stringency of resources for graduate student aid has the same deleterious consequences for the quality of the student body as that previously discussed for undergraduates. The ablest students—those who show the greatest promise and potential—will always have several opportunities for graduate study at first-class universities. For many of them, the availability of support becomes a major, often determinative, factor in the choices they make.

In a recent review of academic funding priorities, the deans of each of the five Schools ranked additional endowment for scholarships and fellowships as the most important issue. Even in those Schools where support for teaching and research assistants is common, fellowship support during a student's first year—when he or she can sort out interests and identify specific fields of study for thesis work—is a great advantage in terms of drawing the most talented and creative students to MIT.

I know that some observers of the academic scene view funds for student aid as discretionary in nature, perhaps even as a luxury. It is clear to me, however, as it is to most of my colleagues in the faculty and administration, that in a world where first-class, publicly supported universities offer education at a lower price, and where the strongest students will always have a choice of where to study, adequate funds for financial assistance to students, both undergraduate and graduate, are *essential* if we are to continue to attract students of such remarkable—some would say stunning—ability and potential. It would serve such students poorly if they were to make their college choices primarily on financial rather than intellectual grounds.

A Richer Educational Environment

I referred earlier to the powerful attraction MIT has for students who seek a real partnership with faculty, and of the need to create an even richer intellectual and social environment for this community of scholars. We are already in the forefront on many dimensions. At the undergraduate level, the Undergraduate Research Opportunities Program has been exceptionally successful in this regard. This year, we are developing additional programs that will further enhance the communion

between generations, cultures, and fields that enriches a student's education.

Many of these initiatives are being developed as a result of a significant organizational change in the academic administration—a change that reinforces the role of education and the importance of educational reform in this institution. One of the first acts taken by Professor John M. Deutch as Provost was to create two new positions: Associate Provost for Educational Programs and Policy, held by Professor Samuel J. Keyser, and Dean for Undergraduate Education, held by Professor Margaret L.A. MacVicar. Professor Keyser heads a team of deans which includes, in addition to Professor MacVicar, Professor Frank E. Perkins, Dean of the Graduate School, and Dr. Shirley M. McBay, Dean for Student Affairs.

The creation of a new academic organization devoted to educational issues both inside and outside the classroom has already borne fruit. The following examples are but headlines of activities that range from freshman orientation and first-year programs to graduate student concerns:

- **Changes in Residence/Orientation week.** In order to introduce new students more effectively into the academic and social life of MIT, a number of changes were made in this year's R/O week. These included providing more time for students to explore academic options; increased involvement of faculty and associate advisors throughout the week; an emphasis on the diversity of MIT, with enhanced orientation programs for women and minorities; and efforts to make residence selection a less hectic and intense focus of the week. We need to do more work in these directions.

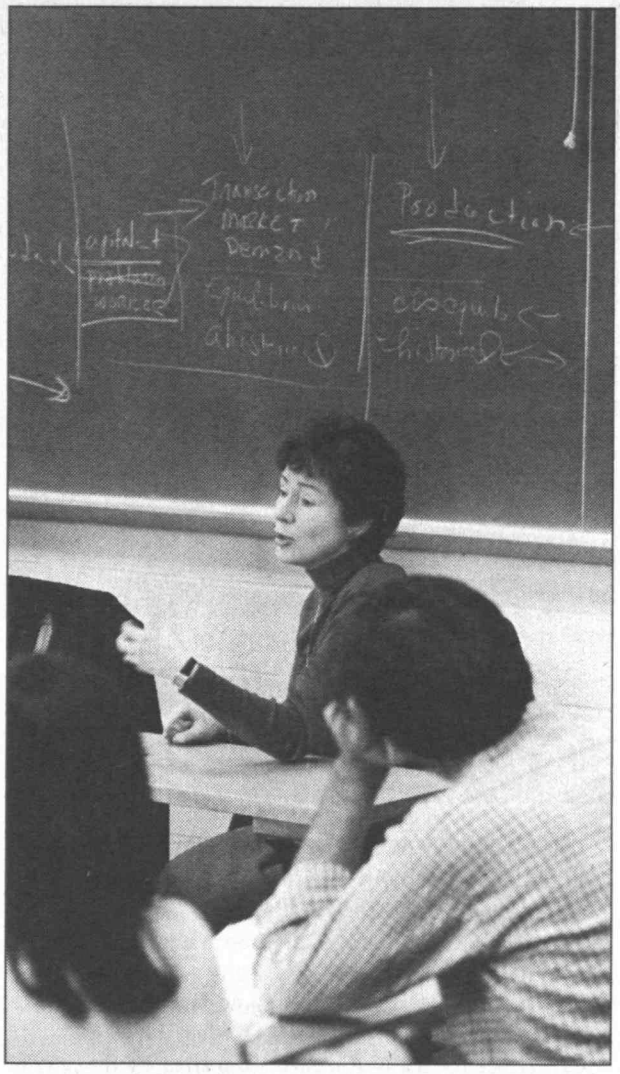
- **New initiatives to improve freshman advising and strengthen the informal intellectual contact between freshmen and faculty members.** These include experiments in having some advisors teach freshman seminars to their advisees; having some advisees and associate advisors grouped in the same house, with advising done in the dormitory setting; and offering some faculty-led undergraduate seminars in the living groups. These experiments are designed to result in improved advising, early exposure of freshmen to the intellectual style of MIT, increased faculty involvement in living groups, better faculty understanding of the freshman year, and a stronger associate advisor program.

- **Linking of mathematics and physics sections in the freshman year.** The content and pace of the basic freshman subjects in calculus and physics are being coordinated, with the same group of students attending the same physics and mathematics sections, thus fostering intellectual and social cohorts within the academic program. This arrangement also affords an opportunity to better deal with the wide spectrum of mathematics backgrounds among entering students.

- **The Institute Colloquium.** Outside the classroom, the Institute Colloquium is a new activity which brings students, faculty, and staff together to discuss major issues of concern to the broader community. The plenary sessions, with speakers from outside as well as inside MIT, are followed by discussions in the living groups and are led by faculty members. Last year, Institute Colloquia were held on the crisis in South Africa, the AIDS epidemic, and economic competition with Japan. The fall Colloquium, cosponsored with the Corporation Joint Advisory Committee, is being planned on recent developments and prospects in South Africa—a subject of continuing concern for members of this community.

- **A new focus of concern on the quality of the social and academic experience for minority students at MIT.** The Office of Minority Education, under its new director, Dr. Joyce Gibson, and in its new home in the Office of the Dean for Student Affairs, is developing its activities in close cooperation with academic departments in supporting minority students through a wide varity of programs. The OME will also be the center for continuing studies relating to the education of minorities at MIT.

  In a coordinated effort to attract more minority students to MIT and to support their success, the Offices of Admissions, Financial Aid, Career Services, and Minority Education have created a program for oustanding minority students entitled Pathway to the Future. The Program consists of four parts. The Practical Experience Program, a new service developed by the Career Services Office, is helping students find substantive summer jobs with companies and government agencies in such fields as natural sciences,



Professor Suzanne Berger lectures in her Political Economy class.

business, planning, and banking. Other parts of the Pathway Program are the Second Summer Program, which places freshmen in design or research departments in engineering organizations; Project Interphase, which offers first-year students a summer introduction to MIT in advance of the freshman year; and special consideration for families of minority students who need financial aid.

In addition to these programs already in place is a two-year study by a large group of faculty and staff, convened by Dean McBay, which will culminate this fall with reports on the racial climate on campus, financial aid considerations, and other special efforts needed to assure the success of minority students at MIT. I hope to report significant progress and renewed initiatives on this front next year at this time.

- **Enhanced attention to graduate student concerns.** The inclusion of the Dean of the Graduate School as part of the team headed by the Associate Provost for Educational Programs and Policy has resulted in greater participation by the Graduate School in the planning of educational policy, particularly where issues of graduate education, undergraduate education, and the quality of student life come together. One such issue has to do with the declining number of minority scientists in this country and the need to bring more minority undergraduates into graduate programs in the sciences. This year the Graduate School, together with the School of Science and the Provost's Office, launched a new program for minority undergraduates interested in scientific careers. The objective of the program is to give students experience in scientific research in a university setting, with the hope that they will eventually pursue doctoral degrees in science. This past summer, the MIT Minority Summer Science Research Program brought eight minority students to campus for 10 weeks to work with faculty, graduate students, and postdoctoral fellows in research laboratories in the School of Science. Plans call for an expansion of this pilot program to 30 students next summer.

  Another set of issues relates to the steady, though unplanned, growth in graduate student enrollments, which now surpass undergraduate enrollments. This issue has raised major policy questions having to do with the impact on the quality of life for all students, the desired relative sizes of the two groups, the effects on faculty research activities, and the impacts and opportunities for controlling the size of the graduate student body—questions that will continue on our agenda in the coming year.

  Related to the issue of graduate enrollment is graduate student housing, which falls far short of meeting the need. Not only does the lack of housing weaken the quality of life for graduate students, but it is beginning to have its effect on our efforts to enroll the strongest graduate students as well. As a result, we are making graduate student housing one of our highest priorities for new funding.

These are examples of the renewed interest on the part of the faculty and administration in creating an individual and campus environment that enhances the education of students at every level and welcomes, values, and learns from the extraordinary mix of intellectual, social, and cultural perspectives among us.

Toward a New Undergraduate Academic Program

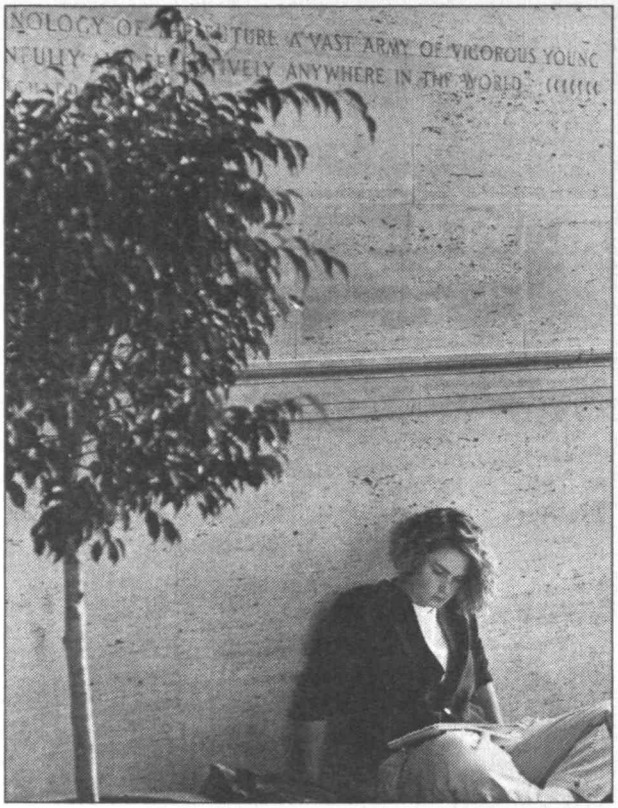
Of all the new initiatives, however, none is more significant than the current assessment and reform of undergraduate education at MIT. The Institute is now engaged in the most intensive review of its undergraduate academic program in 25 years. Sparked by a sense that there is a need in undergraduate education for more integration of perspectives and expertise among fields and a need for a greater common view of an undergraduate program drawing on the special strengths of MIT, faculty in the various Schools have formed into committees to study various aspects of our programs—including undergraduate education in engineering; the core requirements in science and the humanities, arts, and social sciences; and the overall structure and purpose of the undergraduate program itself.

These reviews are being conducted under the auspices of the Deans of the Schools and the Dean for Undergraduate Education. The newly formed faculty Committee on the Undergraduate Program is taking an important role in bringing together the many threads from these various committees into a tentative, interrelated framework for a new set of General Institute Requirements, which would constitute the core of the academic program for every undergraduate at MIT.

During the coming year, the reviews and recommendations of these faculty committees will be under discussion in the faculty at large, in order to develop a broadly shared common conception with regard to the assumptions and purpose of our undergraduate program. The reports and discussions to date indicate a widespread interest among the faculty in educational reform, and I am indebted to the many individuals on the faculty who are taking part in this major undertaking.

This intensive review of the structure and content of undergraduate education at MIT is motivated by several considerations:

- The world in which our students will live and work is changing at ever-increasing rates. This is particularly so in science-based activities and in those fields that generate and are driven by new technology. We have a particular responsibility to insure that the education we provide has value and relevance over a lifetime of professional activity, and that it prepares our graduates for the necessity of continual learning and mastery of ideas not yet conceived. Our most important educational task is to prepare students for independent learning and a lifetime of intellectual self-renewal.



- There is a widely shared, but by no means unanimous, sense that the quality of the MIT educational experience for many students is impaired by the intensity or pace of our programs. This is a community of highly motivated and energetic high-achievers. Many would subscribe to Mae West's view that "too much of a good thing is wonderful." If a normal load is five subjects, why not take six or seven since the rules of the Institute permit it? What can be the harm in taking on one more committee assignment in addition to that peer-review panel for the National Academy of Sciences? After all, the subject is important, one is interested in it, and one can always squeeze out a bit more time from teaching, research supervision and participation, consulting, and that manuscript which is going so slowly. I am convinced that the self-reinforcing habits of overextension, which are part of the lives of so many members of this community—students, faculty, staff, and administrators alike—exact a toll on creativity, collegiality, and the quality of our community life, and I believe that an intentional, modest reduction in pace,

A student in need of a place to study stakes out a bench in Lobby 10.

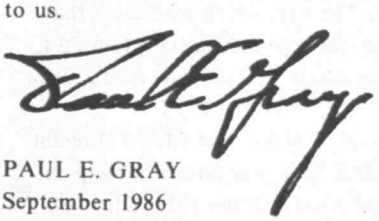
in intensity, with more time for contemplation and reflection would be desirable. If this is to occur, we need to understand the ways in which the structure of the curriculum and the long-standing tradition of absolute freedom of choice in registration contribute to or reinforce this behavior.

- At MIT and elsewhere, the structure of undergraduate engineering education—always a compromise with respect to the time allocated to three competing and essential elements; mathematics, science, and engineering fundamentals; humanities, arts, and social sciences; engineering applications, including design experience—is widely thought to be overconstrained. It may be time to recognize that an undergraduate degree at MIT may provide the best foundation for professional engineering studies, but that proper professional qualifications may well require additional educational and learning experiences and that continued learning is an essential element in the career of an engineer.
- Many members of the faculty and many undergraduate students are dissatisfied with the present structure of the Institute Requirement in the humanities, arts, and social sciences. There is general agreement on the proposition that all MIT undergraduates should receive a broad foundation in the humanities, arts, and social sciences; that they should develop their capacities in areas of learning that are contextual and interpretive and should learn to make reasoned judgments employing non-quantitative modes of analysis; and that they should develop their abilities to express their thoughts and feelings through writing and speaking. But there is also a clear sense that the present Institute requirements do *not* achieve these purposes. Under the current HASS requirement, there is no assurance of adequate breadth in the individual student's programs, there are no common elements in those programs, and many of the subjects that can be used to satisfy the present requirements are highly quantitative or are designed primarily to teach professionally useful skills.

We at the Institute have both a heavy responsibility and a great opportunity with respect to undergraduate education. That responsibility is associated with the fact that the students who come to us represent, in terms of past achievement, future promise, and innate abilities, an extraordinary selection of young men and women. Most will lead lives of personal and social significance and will have careers that make a difference. Many will achieve greatness in what they undertake, and many will grow into positions of leadership in the professions, in the world of industry and commerce, and in government. We must make the best possible use of the few years these young people are with us, for they represent an extraordinary human resource—one that matters to this nation and to the world.

We have a great opportunity—not only because these young people are so very able but also because in its programs and, most importantly, in its faculty this special place embodies a range of fields and activities of particular relevance to the world of the 21st century. Increasingly, the issues and choices facing societies, developed and developing, have crucial scientific or technological components, and wise, humane choices will require scientific literacy among leaders and shapers of opinion. One would hope for greater scientific literacy among citizens at large; regrettably, public secondary education seems to be moving in the opposite direction. At the same time, the evident impact of science and technology on public affairs and human well-being requires that those who shape or influence these developments appreciate the diversity and complexity of socieites and human values and have an ability to understand and respect the economic, political, social, and environmental issues associated with the technical developments and applications of science.

The Institute embodies these skills and intellectual disciplines, and we have the capacity to educate in ways that nurture and develop these multiple competencies, even as our students have the capacity to appreciate and master these complementary perspectives. One of the greatest resources we can place in the service of this mission is our tradition of faculty and students working and learning together—in a spirit that encourages the best each has to offer and that reflects a degree of collegiality that is remarkable for a research university. In these respects, MIT is singular. It is a singularity that gives me reason to be very hopeful about the ways in which we will discharge the educational responsibility we hold, and meet the educational opportunities presented to us.



PAUL E. GRAY
September 1986

In Special Recognition

The special character of MIT is seen each year in the achievements and honors of its faculty. While it is not possible to take note of every such distinction, there are some highlights which deserve mention.

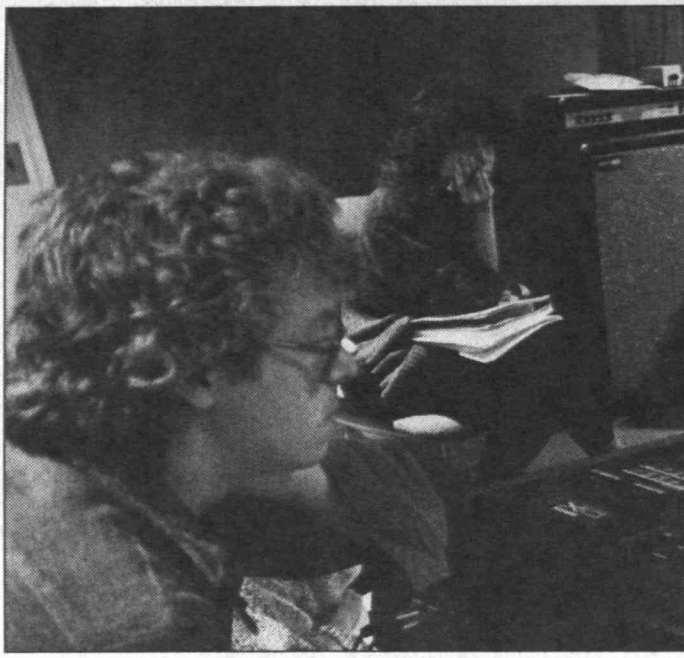
In the early spring, the National Academy of Engineering elected five members of the MIT Faculty. New MIT members are: H. Kent Bowen, Professor of Materials Science and Engineering and Director of the Manufacturing and Processing Systems Program; Chiang C. Mei, Professor of Civil Engineering; Joel Moses, Professor and Head of Electrical Engineering and Computer Science; Kenneth N. Stevens, Professor of Electrical Engineering and Computer Science; and Daniel I.C. Wang, Professor of Chemical Engineering and Applied Biological Sciences, and Director of the Biotechnology Center.

During the spring, four members of the faculty were elected members of the National Academy of Science. Those new MIT members are: Emilio Bizzi, Eugene McDermott Professor in Brain Sciences and Human Behavior and Director of the Whitaker College of Health Sciences, Technology, and Management; Daniel Kleppner, Professor of Physics; Sheldon Penman, Professor of Biology; and Susumu Tonegawa, Professor of Biology in the Center for Cancer Research.

Seven members of the MIT faculty were among those elected as Fellows of the American Academy of Arts and Sciences at its May meeting. New MIT members are: Daniel Z. Freedman, Professor of Applied Mathematics; Daniel Kleppner, Professor of Physics; Stephen J. Lippard, Professor of Chemistry; Richard B. Melrose, Professor of Mathematics; Robert C. Merton, Professor of Management; Peter Temin, Professor of Economics; and Martin L. Weitzman, Professor of Economics.

In October 1985, Professor Franco Modigliani was awarded the 1985 Alfred Nobel Memorial Prize in Economics. The award was given for his pioneering analyses of how individual savings patterns and capital markets influence the overall course of national economies. His "life-cycle" theory, which maintains that people routinely vary their savings during their lifetimes, has been adopted by economists to study everything from retirement to taxes.

David Epstein, Professor of Music and Music Director of the MIT Symphony Orchestra, was named a recipient of the Senior US Scientist Award of the Alexander von



Humboldt Foundation for his research into questions of time process and time structure in music, which was amalgamated music theory with aspects of neurophysiological timing mechanisms that seem to control timing in music making.

In the spring, Herman Feshbach, Institute Professor and Professor of Physics, received the National Medal of Science for his distinguished contributions to science as a leader in physics education.

Bruce Mazlish, Professor of History, was awarded The Toynbee Prize this spring for his theories exploring the impact of psychology on history and public policy. A major international award, The Toynbee Prize is awarded biannually to an outstanding scholar for work enriching the social sciences.

The 1985 Enrico Fermi Award, presented by the United States Department of Energy, was given this year to Norman C. Rasmussen, Professor of Nuclear Engineering, in recognition of his pioneering work in developing probabilistic risk assessment methods for analyzing reactor safety.

Susumu Tonegawa of the Center for Cancer Research and the Department of Biology received the ninth annual Bristol-Myers Award for Distinguished Achievement in Cancer Research for his work in deciphering the genetic basis of how the immune system works.

In May, Sheila E. Widnall, Professor of Aeronautics and Astronautics, became president-elect of the American Association for the Advancement of Science, the world's leading general scientific organization.

The National Academy of Engineering announced in July 1985 that Jerome B. Wiesner, President Emeritus

Lecturer David Levitt notes the technique of one of the students in his Entertainment Engineering class held in the Arts and Media Technology Building.

and Institute Professor, was the recipient of the Arthur M. Bueche Award for his personal leadership at the highest levels in the area of high-performance communication systems, science policy in the Federal government, and scientific and engineering education.

Within the Institute, Mildred S. Dresselhaus, Abby Rockefeller Mauze[1] Professor of Electrical Engineering and Physics, was named an Institute Professor. The title of Institute Professor is an honor bestowed by the faculty on a colleague for distinguished accomplishments in scholarly, educational, service, and leadership pursuits. Professor Dresselhaus has focused her scholarly attention on electronic, optical, and magnetooptical properties of semiconductors and semimetals. She has earned a national reputation as an educator and leader in developing wider opportunities for women in science and engineering.

Later in the spring, Professor Dresselhaus was selected as the 1986-87 recipient of the James R. Killian, Jr., Faculty Achievement Award. The Killian Award, established in 1971 as a tribute to MIT's tenth president, recognizes extraordinary professional accomplishments and service. The committee's citation notes that Professor Dresselhaus "through her professional and her personal lives, gives distinction to MIT, but also human coherence and purpose."

In May, Jeffrey H. Lang, Associate Professor of Electrical Engineering and Computer Science, was named the 1986 recipient of the Harold E. Edgerton Faculty Achievement Award. This Award recognizes young faculty members for outstanding achievements in research, scholarship, and teaching. The committee's citation notes that Professor Lang "has demonstrated a commitment to excelling on each of these dimensions... He brings to his work insight that combines the discipline of microprocessors, power electronics, field theory, control, and other areas." It further states that Professor Lang's "skill and dedication as a teacher is well known among faculty and students."

* * *

This past year, several key leadership roles at the Institute changed, and those transitions were occasion for special recognition.

Several changes in senior posts in the academic administration were announced this past year. In September, Professor Jack L. Kerrebrock, the Richard Cockburn Maclaurin Professor in Aeronautics and Astronautics and Head of the Department of Aeronautics and Astronautics, was named Associate Dean of the School of Engineering. New department or program heads appointed or announced during the past year are: Richard S. Eckaus, Head of the Department of Economics; Shaoul Ezekiel, Director of the Center for Advanced Engineering Study; Kenneth Keniston, Director of the Program in Science, Technology, and Society; Richard J. Kitz, Codirector of the Harvard-MIT Division of Health Sciences and Technology; Claire Kramsch, Section Head of Foreign Languages and Literatures; Tunney F. Lee, Head of the Department of Urban Studies and Planning; Robert W. Mann, Director of Bioengineering Programs at the Whitaker College of Health Sciences, Technology, and Management; James McKellar, Director of the Center for Real Estate Development; Joseph M. Sussman, Director of the Center for Transportation Studies; and Harry L. Tuller, Director of the Crystal Physics and Optical Electronics Laboratory.

Several changes in the Institute's central administration also were announced during the year. In the spring, Professor James D. Bruce, Director of Information Systems, was appointed to the new position of Vice President for Information Systems, effective July 1. As vice president, Professor Bruce will be the senior officer responsible for directing the evolution, integration, and effective use of computing and communications resources throughout MIT.

Mr. Glenn P. Strehle, Treasurer of the MIT Corporation since July 1975, was appointed to succeed

Professor Samuel A. Goldblith as Vice President for Resource Development effective March 1, 1986. He will continue to be treasurer of the Corporation and his new title will be Vice President and Treasurer. Professor Goldblith, who served as Vice President for Resource Development for the past seven years, will return to teaching and research as Professor of Food Science in the Department of Applied Biological Sciences and will also remain part-time as Senior Advisor to the President for Resource Development.

At the October 4, 1985, meeting of the Corporation, Mr. Constantine B. Simonides was elected Secretary and ex officio member of the MIT Corporation. He will continue his current duties as Vice President in the Office of the President.

Other appointments include the appointment in the spring of Mr. Kenneth D. Campbell as Director of the MIT News Office, Dr. Allan S. Bufferd as Deputy Treasurer and Director of Investments, and Dr. Joyce T. Gibson, as Director of the Office of Minority Education.

In this section of my report, I would like to take special notice of the fact that in the last two years 30 members of underrepresented minority groups, 26 of them black, joined the Institute's administrative staff. This addition represents more than 30 percent of the minority component, which is under 100 out of a total staff of 900. I wish I could have reported similar progress in the recruitment of faculty members.

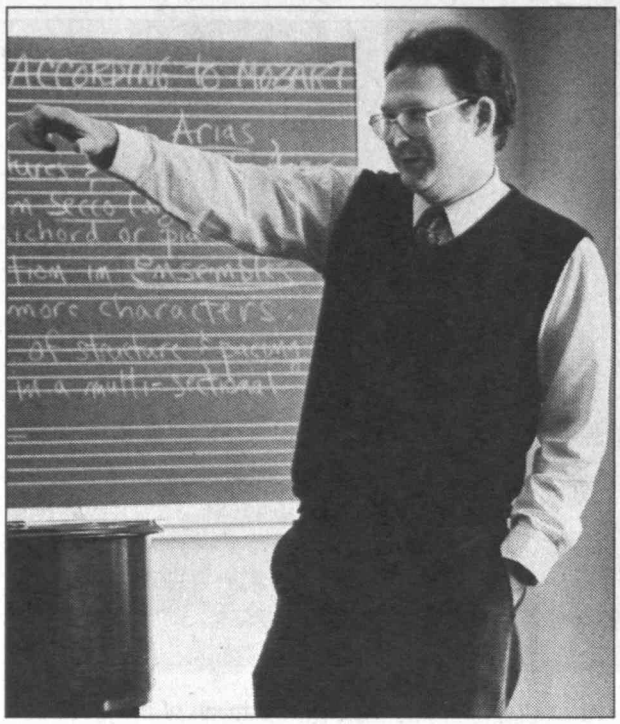
* * *

The Institute was saddened this year by the deaths of several longtime friends and colleagues. We miss them and are grateful for their contributions to this community.

John B. Babcock, Professor of railway engineering emeritus in the Department of Civil Engineering, died in February 1986 at the age of 96. A 1910 graduate of MIT, he served on the faculty from 1916 until his retirement in 1954.

In April 1986, Lloyd D. Brace, former president and chairman of the First National Bank of Boston and a Life Member Emeritus of the MIT Corporation, died at age 83. As a member of the MIT Corporation, Mr. Brace played a prominent role in the planning and financing of capital projects for the Institute, and had a long and distinguished record of visiting committee service.

Douglass V. Brown, Jr., a renowned arbitrator and a professor emeritus in the Sloan School of Management, died at the age of 82 in March 1986. His service to the



Institute spanned a period of 36 years, during which time his expertise in the field of industrial relations and arbitrations influenced generations of students.

In March 1986, Secor D. Browne, a former faculty member who was chairman of the Civil Aeronautics Board from 1969-1973, died at age 69. His varied interests enabled him to hold joint appointments at MIT in the Department of Aeronautics and Astronautics and the Department of Modern Languages.

Martin J. Buerger, a retired professor renowned for his laboratory and pioneering work in the application of X-ray crystallography, died at age 82 in February 1986. In 1920 he enrolled as an undergraduate at MIT and then served for 55 years at the Institute as professor of mineralogy and crystallography. In 1944 he was appointed Institute Professor, a rank of special distinction conferred by fellow faculty members.

Donald F. Carpenter, former general manager of the Film Department of E.I. du Pont de Nemours and Company and senior Life Member Emeritus of the MIT Corporation, died in September 1985 at the age of 86. A member of the class of 1922, his association with MIT spanned more than six decades, during which time he served as a trusted advisor to five MIT presidents and four of the Corporation's chairmen.

In January 1986, Morton Finston, a retired professor of aeronautics and astronautics, died at the age of 66. He served on the MIT faculty for 33 years until his retirement in 1984. His fundamental work was in aerodynamics and heat transfer.

Lecturer Marty Marks of the Music Section illustrates a point on comic opera in his Introduction to Music class.

Billy E. Goetz, who served as a professor of management at the Sloan School from 1954 until his retirement in 1969, died in September 1985 at the age of 81. At Sloan, Professor Goetz specialized in production management and managerial accounting with a focus on definitions, characteristics, and sources of information for managerial planning and control.

In January 1986, August L. Hesselschwerdt, Jr., professor emeritus of mechanical engineering, died at the age of 75. A graduate of MIT, he returned to the Institute in 1942 as a member of the faculty, remaining until his retirement in 1975.

Harold R. Isaacs, professor emeritus of political science and a noted writer on Asian, African, and American affairs, died in July of 1986. He started his career as a writer and journalist, establishing his literary reputation at age 28 with the publication of his study of the Chinese Revolution of 1925-27. Professor Isaacs came to MIT as a research associate in 1953 and served as professor of political science from 1965 until his retirement in 1976.

Thomas B. King, professor in the Department of Materials Science and Engineering, died at the age of 62 in November 1985. Professor King joined the MIT faculty in 1953 as was widely known for his dedicated teaching and concern about the undergraduate educational experience. He was a leading authority in chemical metallurgy and chemical kinetics.

Edwin Kuh, a professor of economics and finance and a pioneering figure in econometric studies, died in June 1986 at the age of 61. Holding joint appointments in the Sloan School of Management and the Department of Economics, he was an authority on econometric models and the measurement of their reliability to forecast such functions as production, savings, investment, business cycles, and unemployment.

Roy Lamson, professor of literature emeritus, died at the age of 78 in May 1986. He was a champion of the arts and humanities at MIT, the creator of Course XXI, and was a founding member of the Council for the Arts at MIT. In addition to his teaching, he was a writer, an historian with an interest in international relations and military affairs, and a talented clarinet player who was a founding member of The Intermission Trio.

Robert A. Lovett, an international financier and Life Member Emeritus of the Corporation, died in May 1986 at the age of 90. Mr. Lovett was associated with Brown Brothers Harriman for more than 60 years and served as a member of the MIT Corporation since 1955.

Philip M. Morse of the Department of Physics died in September 1985 at the age of 82. His interests ranged from underwater acoustics to astrophysics, and he made pioneering and seminal contributions to the science and practice of operations research, the use of computers in research, and the civilian uses of atomic power.

Shatwell Ober, the aeronautics engineer whose pioneering research in wind tunnel design and testing made significant contributions to aviation, died in September 1985 at age 91. A 1916 graduate of MIT, he returned to MIT in 1922 and remained on the faculty until his retirement in 1959.

Fairfield E. Raymond, 89, an MIT alumnus and faculty member, died in November 1985. He taught in the Department of Electronics from 1928 to 1930 and in the Department of Business and Engineering Administration, the forerunner to the Sloan School of Management, from 1930 to 1939.

David J. Rose of the Department of Nuclear Engineering died in October 1985 at the age of 63. He had been a member of the MIT faculty since 1958 and was recognized for a distinguished career as scientist and engineer, technology and policy analyst, and bridge builder between the scientific and theological communities.

John T. Rule II, professor emeritus of Mechanical Engineering, former Dean of Students and head of General Science and General Education, died at age 85 in May 1986. A 1921 graduate of MIT, he served on the faculty from 1936 until his retirement in 1966, including five years as Dean of Students from 1956-1961.

Karl L. Wildes, professor emeritus in the department of Electrical Engineering and Computer Science, died in April 1986 at age 90. He was noted for his work in the applications of mathematical physics to network theory, especially in the transmission and distribution of electrical power, and for his contributions to the development of cooperative education at MIT. More recently, in 1985 he completed with coauthor Nilo A. Lindgren a major historical work entitled *A Century of Electrical Engineering and Computer Science at MIT, 1882-1982,* which was published by the MIT Press.

John J. Wilson, an industrialist who founded several successful companies, a yachtsman who sailed the Atlantic five times, a Life Member of the MIT Corporation, and a prominent Boston-area trustee, died in December 1985 at the age of 78. An MIT graduate, he became an outstanding leader in MIT alumni affairs,

serving the Institute in a number of capacities including Secretary of the Corporation.

In July of 1986, Dr. Jerrold R. Zacharias, recognized internationally as a leader in nuclear physics and in educational reform, died at the age of 81. An Institute Professor Emeritus and professor emeritus of physics, Dr. Zacharias was widely known for his investigations of the radio frequency spectra of atoms which led to the first atomic clock. His distinguished service to physics education included the formation of the Physical Science Study Committee (PSSC) in 1956 which developed a new method for teaching physics in high schools.

STATISTICS FOR THE YEAR

The following paragraphs report briefly on various aspects of the Institute's activities and operations during 1985-86.

Registration

In 1985-1986 student enrollment was 9,787, compared with 9,626 in 1984-85. This total was comprised of 4,541 undergraduates (compared with 4,536 the previous year), and 5,246 graduate students (compared with 5,090 the previous year). Graduate students who entered MIT last year held degrees from 412 colleges and universities, American and foreign. The international student population* was 2,249, representing 13 percent of the undergraduate and 31 percent of the graduate population. These students were citizens of 96 countries.

In 1985-86, there were 2,218 women students (1,176 undergraduate and 1,042 graduate) at the Institute, compared with 2,211 (1,157 undergraduate and 1,054 graduate) in 1984-85. In September 1985, 290 first-year women entered MIT, representing 27 percent of the entering class.

In 1985-86, there were 1,241 minority** students (1,047 undergraduate and 194 graduate) at the Institute, compared with 1,189 (1,021 undergraduate and 168 graduate) in 1984-85. The first year class entering in September 1985 included 285 minority students, comprising 27 percent of the class.

*Includes permanent residents.

**Minority students include 295 Blacks (non-Hispanic), 22 Native Americans, 234 Hispanics, and 690 Asian Americans.

Degrees Awarded

Degrees awarded by the Institute in 1985-86 included 1,231 bachelor's degrees, 1,059 master's degrees, 54 engineer's degrees, 455 doctoral degrees—a total of 2,799.

Student Financial Aid

During the academic year 1985-86 the student financial aid program was again characterized by an increase in the overall need for financial aid and in the aggregate amount of grants made available. There was an increase in the amount of MIT loans awarded. Federally guaranteed loans obtained from commercial sources showed a small decrease.

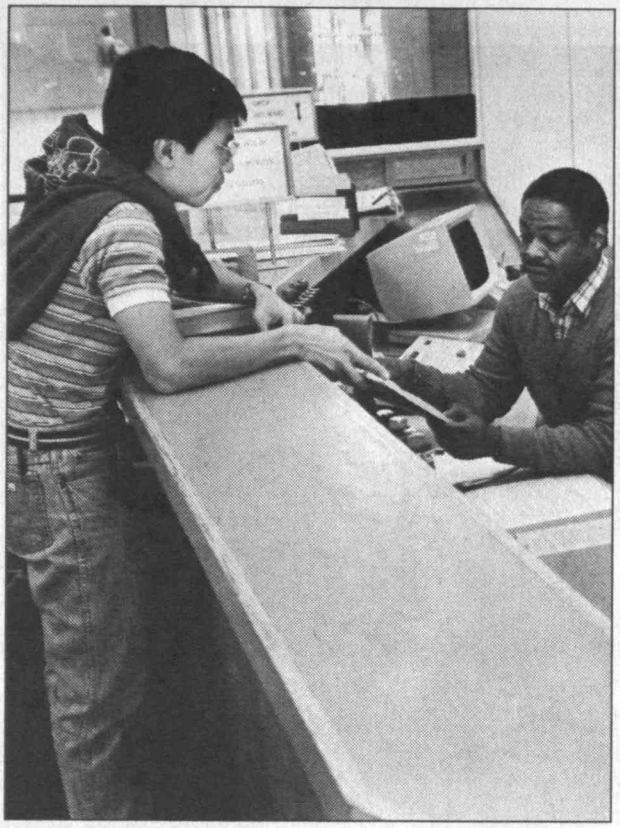
A total of 2,456 undergraduates who demonstrated the need for assistance (54 percent of the enrollment) received $15,733,000 in grant aid and $3,275,000 in loans. The total, $19,008,000, represents a 6 percent increase in aid compared to last year.

Grant assistance to undergraduates was provided by $4,440,000 in income from the scholarship endowment, by $2,129,000 in outside gifts and Federal allocations to MIT for scholarships, and by $3,484,000 in direct grants from outside sources, including ROTC, to needy students. In addition, $5,586,000 in scholarships from MIT's unrestricted funds was provided to undergraduates. The special program of scholarship aid to minority group students represented an additional $94,000 from specially designated funds. An additional 702 students received grants from outside agencies, irrespective of need. The undergraduate scholarship endowment was aided by the addition of $2,292,000 in new funds which raised the principal of the endowment to $40,418,000*.

Loans totalling $3,275,000 were made to needy undergraduates—a 6 percent increase from last year. Of this amount $823,000 came from the Technology Loan Fund and $2,452,000 from the National Direct Student Loan Fund. Not included in the foregoing summary is an additional $5,629,000 obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources. This represents a 1.5 percent decrease in the use of these programs over last year.

Graduate students obtained $1,396,000 from the Technology Loan Fund, $362,000 of which was loaned to international students and did not qualify for the Federal

* Book Value. Market Value as of June 30, 1986, is $113,400,000.



Hayden Library staff member Dan Holland assists a student.

interest subsidies and guarantees available under the Guaranteed Student Loan Program. In addition, $120,000 was loaned by MIT under the Guaranteed Student Loan Program. The total, $1,516,000 represents a 7 percent decrease from last year's level. Graduate students obtained $3,395,000 from outside sources under the Guaranteed Student Loan Program—about the same as last year. The total loaned by MIT to both graduate and undergraduate students was $4,791,000, a 2 percent increase over last year.

Career Services and Preprofessional Advising

The number of offers reported by students and employers to the Office of Career Services trailed last year's figures in most fields of engineering. The decrease was particularly noticeable in chemical and mechanical engineering. In chemical engineering there were fewer seniors looking for work because fewer sophomores have been choosing chemical engineering, but students in mechanical engineering felt the sting of fewer openings and some were without jobs at graduation. Three fields in which the number of offers was up were aeronautics and astronautics, civil engineering, and computer science. This reflects, perhaps, the rise in defense spending, the current construction boom, and increased dependence on computers in every walk of life.

In all, 395 companies and government agencies recruited through the office and conducted 8,978 interviews. This compares to 431 employers recruiting on campus, and 9,012 interviews in 1984-85. At the bachelor's level, salary offers to MIT students rose sharply in dollar amounts in civil engineering, and rose by more than the inflation rate in mathematics, materials science and engineering, aeronautics and astronautics, computer science, and chemical engineering. Offers trailed the inflation rate in electrical and mechanical engineering. Offers to masters in engineering were generally up by more than the inflation rate. Offers to doctoral candidates were up by more than the inflation rate. Offers to doctoral candidates were up by more than the inflation rate in electrical engineering and materials science, but stayed at last year's dollar figures in chemical and mechanical engineering.

Bucking a national decline in the number of applicants to medical school, MIT fielded 122 candidates in 1985-86 compared with 114 in 1984-85 (also an increase over the previous year). Of the 122, 87 were undergraduates, 10 were graduate students, and 25 were alumni. Preliminary returns indicate that 73 of the undergraduates (84 percent), 8 of the graduate students (80 percent), and 18 of the alumni (72 percent) were accepted.

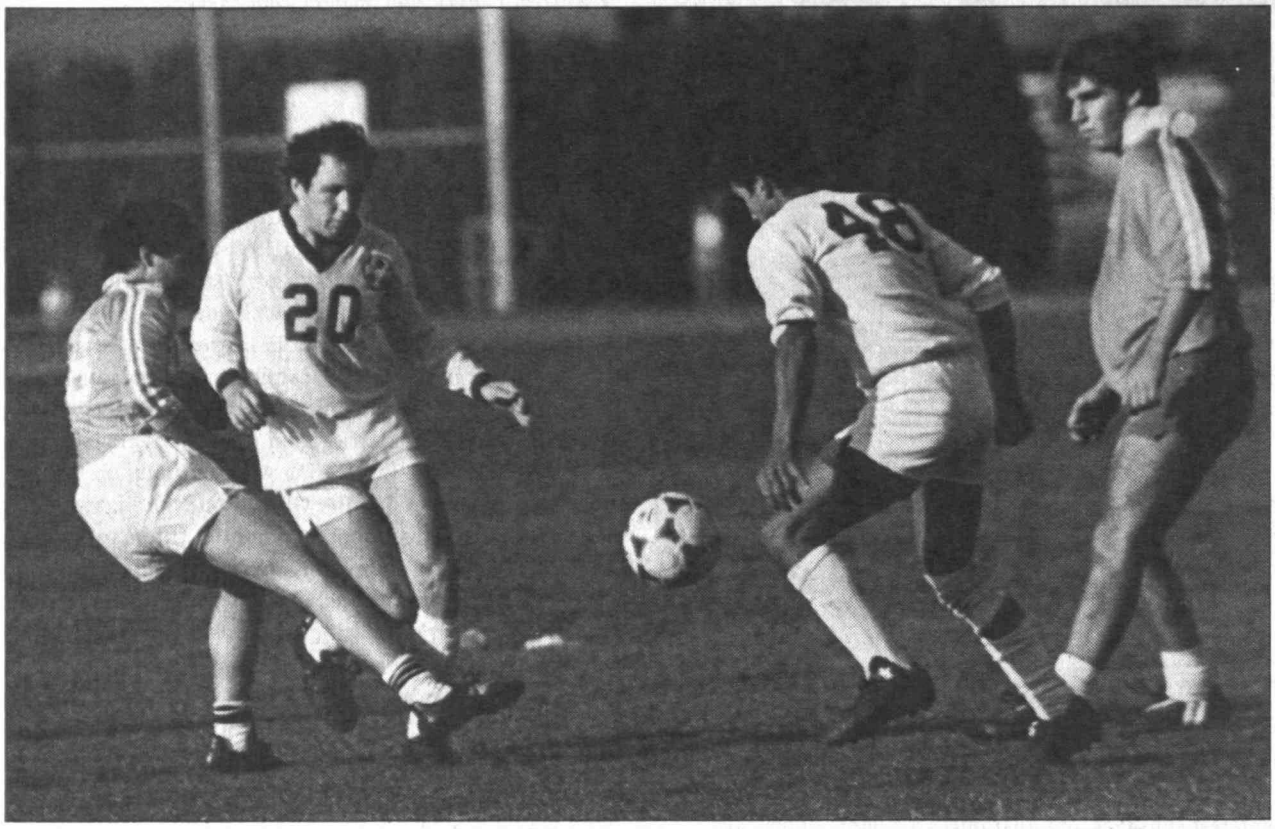
Twenty-six MIT candidates are known to have applied to law school, among them 18 undergraduates.

Finances

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, amounted to $790,803,000, an increase of 10 percent over 1984-85. Education and general expenses—excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory—amounted to $331,092,000 during 1985-86, compared to $299,035,000 in 1984-85. The direct expenses of departmental and interdepartmental sponsored research on campus increased from $168,311,000 to $179,648,000; and direct expenses of the Lincoln Laboratory's sponsored research increased from $249,841,000 to $280,063,000.

Current revenues used to meet the Institute's operating expenses totalled $789,184,000, augmented by $1,619,000 in unrestricted gifts. After meeting these expenses, a surplus of $1,507,000 in current unrestricted gifts was held at year-end.

The construction program of the Institute continued to make progress in 1985-86, with book value of educational



plant facilities increasing from $306,490,000 to $321,681,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, students' notes receivable, and amounts due from education plant, had a book value of $784,089,000 and a market value of $1,175,678,000. This compares to book and market values of $679,820,000 and $920,658,000 last year.

Gifts

Gifts, grants, and bequests to MIT from private donors declined by 11 percent in 1985-86 to $54,783,000, as compared to $61,714,000 in 1984-85. The Alumni Fund reported gifts of $11,178,000 for the year, another record.

Physical Plant and Campus Environment

The Arts and Media Technology Building was completed early in the year and officially dedicated in October in honor of Jerome B. and Laya W. Wiesner. Construction of an Experimental Media Facility in unfinished space within the building commenced in late spring and is scheduled for completion early next winter. The fitting out of the Microsystems Technology Laboratory was completed in the spring and most of the laboratories in the facility are now operational.

Major utility, service, and restoration projects completed this year include extension of the central chilled water system to the National Magnet Laboratory on the northwest campus; rehabilitation and modernization of elevators in Buildings 54, 56, and E52; and restoration of the parking garages. The main staircase of the Stratton student center and the Kresge brick plaza were substantially reconstructed.

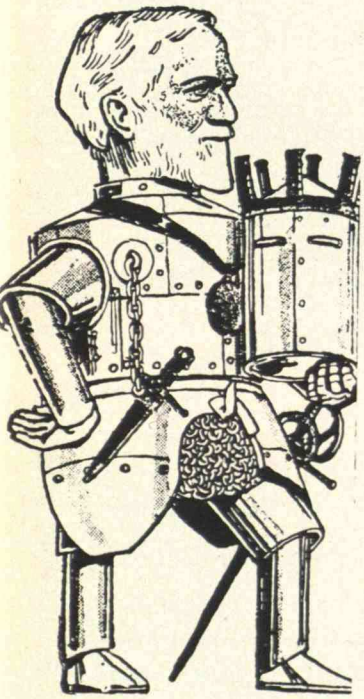
Again this year, modernization and maintenance of the housing system was a high priority. Over $1 million was invested in restoration and repairs at Senior House and the East Campus dormitories. In addition, one of our most successful projects with respect to its positive environmental impact, namely landscaping of the area around the East Campus dormitories and Walker Memorial, was also completed.

During the year, MIT and AT&T-Information Systems entered into an agreement to replace MIT's present Centrex and Dormline systems with a 5ESS digital switching or PBX system. As part of this project, a new universal interior wiring system must be installed throughout the Institute. Work on this phase of the project began this year. The 5ESS system is scheduled to be completed and in service by June of 1988. Gateways to campus computer networks have now been installed in 19 different building locations, enabling various computer users throughout the campus to share resources and transfer files. In addition, a number of departmental local area networks were installed during the year.

Thomas Edison embodied the view that scientific and technological innovation is a sufficient basis for progress.

often seems to arouse anxiety, dislocation, and foreboding. Henry Thoreau's detailed, carefully composed account of the intrusion of the railroad into the Concord woods is a good example; it bears out his delineation of the new inventions as "improved means to unimproved ends."

This critical view of the relationship between technological means and social ends did not merely appear in random images, phrases, and narrative episodes. Indeed, the whole of *Walden* may be read as a sustained attack on a culture that had allowed itself to become confused about the relationship of ends and means. Thoreau's countrymen are depicted as becoming "the tools of their tools." Much the same argument underlies Hawthorne's satire, "The Celestial Railroad," a modern replay of *Pilgrim's Progress* in which the hero, Christian, realizes too late that his comfortable railroad journey to salvation is taking him to hell, not heaven. Melville incorporates a similar insight into his characterization of Captain Ahab, who is the embodiment of the Faustian aspiration toward domination and total control given credence by the sudden emergence of exciting new technological capacities. Ahab exults in his power over the crew, and he explicitly identifies it with the power exhibited by the new railroad spanning the North American continent. In reflective moments, however, he also acknowledges the self-destructive nature of his own behavior: "Now in his heart, Ahab had some glimpse of this, namely, all my means are sane, my motive and my object mad."



Andrew Carnegie, here garbed as a white knight, represented the technocratic ideal of progress.

Of course there was nothing new about the moral posture adopted by these American writers. Indeed, their attitude toward the exuberant national celebration of the railroad and other inventions is no doubt traceable to traditional moral and religious objections to such an exaggeration of human powers. In this view, the worshipful attitude of Americans toward these new instruments of power had to be recognized for what it was: idolatry like that attacked by Old Testament prophets in a disguised, new-fashioned form. This moral critique of the debased, technocratic version of the progressive worldview has slowly gained adherents since the mid-nineteenth century, and by now it is one of the chief ideological supports of an adversary culture in the United States.

The ideas of writers like Hawthorne, Melville, and Thoreau were usually dismissed as excessively idealistic, nostalgic, or sentimental, hence impractical and unreliable. They were particularly vulnerable to that charge at a time when the rapid improvement in the material conditions of American life lent a compelling power to the idea that the meaning of history is universal progress. Only in the late twentieth century, with the growth of skepticism about scientific and technological progress, and with the emergence of a vigorous adversary culture in the 1960s, has the standpoint of that earlier eccentric minority been accorded a certain intellectual respect. To be sure, it is still chiefly the viewpoint of a relatively small minority, but there have been times, like the Vietnam upheaval of the 1960s, when that minority has won the temporary support of, or formed a tacit coalition with, a remarkably large number of other disaffected Americans. Much the same anti-technocratic viewpoint has made itself felt in various dissident movements and intellectual tendencies since the 1960s: the anti-nuclear movements (against both nuclear

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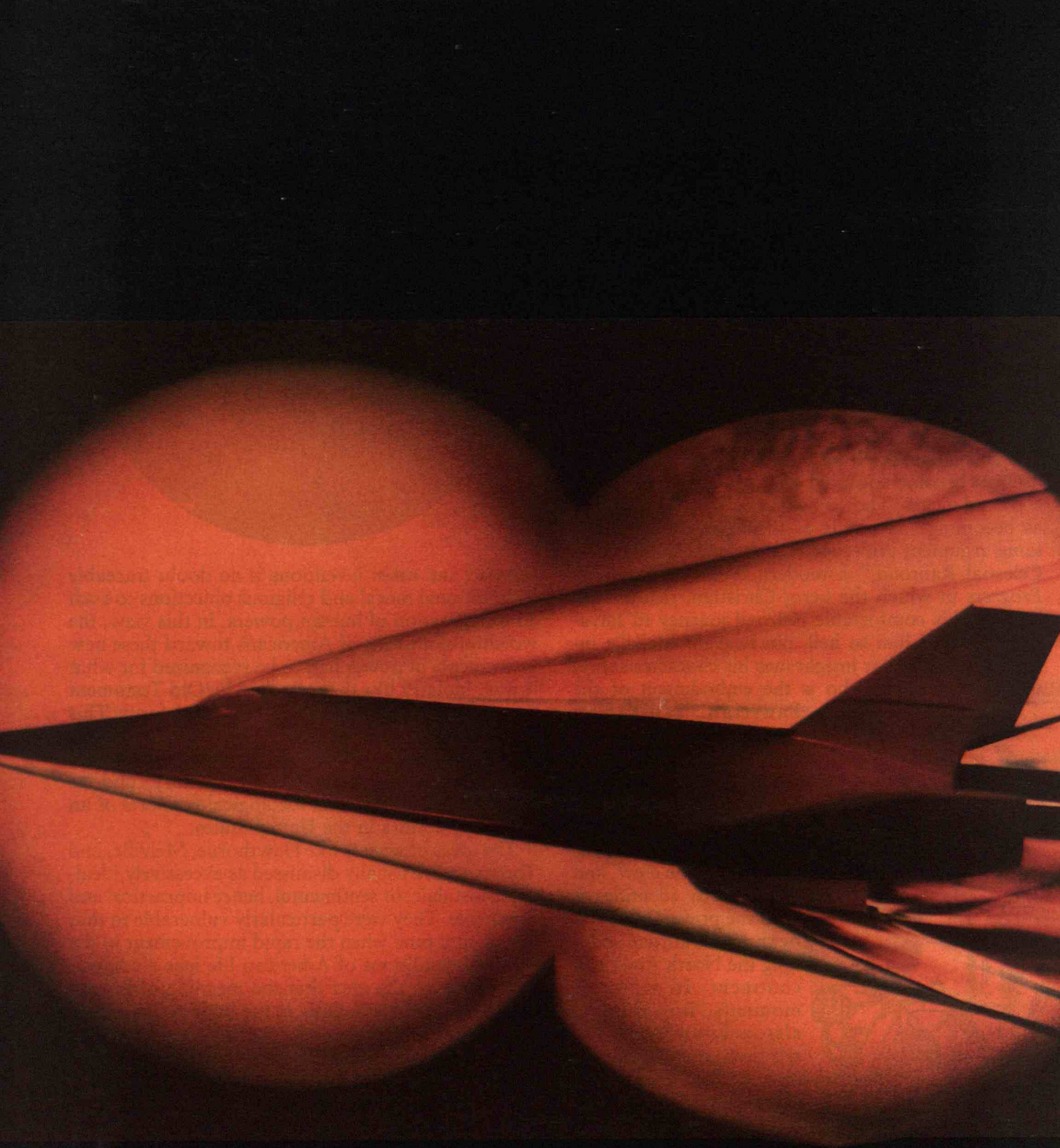


In the 1970s, NASA conducted wind-tunnel tests to investigate the concept of an aircraft that could fly at more than five times the speed of sound. Special photographic methods helped researchers understand the complex airflow at such high speeds.

Will the Aerospace Plane Work?

BY STEPHEN W. KORTHALS-ALTES

In his 1986 State of the Union Address, President Reagan spoke of an aerospace plane that could, "by the end of the next decade . . . fly [from Washington] to Tokyo within two hours." Ex-presidential science advisor George A. Keyworth II told a congressional subcommittee that ticket prices for a civilian version, the hypersonic transport (HST), could compete with today's ticket prices.

Best of all, according to Keyworth, the aerospace plane would not require massive development efforts. "This technology is here. . . . It is simply waiting to be used and put together and assembled in an innovative fashion." Official Pentagon estimates of the R&D costs are about $3 billion, a veritable pittance for space endeavors.

A Department of Defense (DOD) press release envisions that "a future aerospace plane would be able to operate as an airplane at hypersonic velocities (4,000 to 8,000 miles per hour) . . . or as a space launch vehicle capable of accelerating directly into orbit." Military leaders boast that it could reduce launch costs from about $2,000 per pound to $20 per pound.

Says General Lawrence A. Skance, commander of the Air Force Systems Command, "We are talking about the speed of response of an ICBM and the flexibility and recallability of a bomber, packaged together in a plane that can scramble, get into orbit, and change orbit so that the Soviets can't get a reading accurate enough to shoot at it."

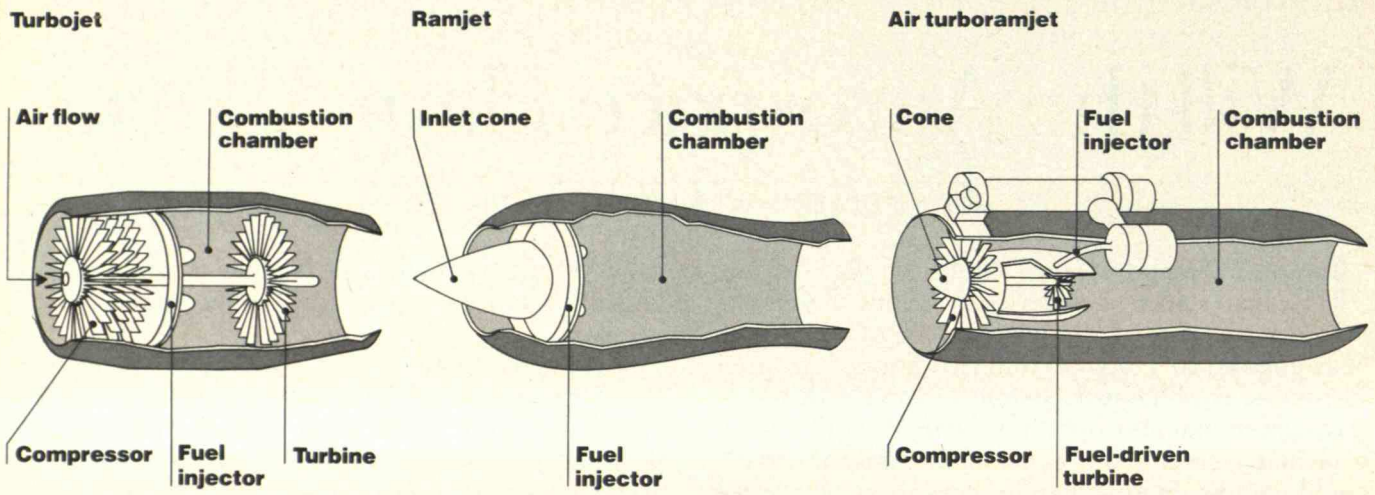
Much of this talk is hypersonic hyperbole. The technological challenges have been downplayed, the development costs are grossly underestimated, and the utility of the aircraft is vastly exaggerated. This vehicle would be the most complex aircraft ever attempted, and its true development

The Reagan administration proposes the aerospace plane as a successor to the space shuttle, a commercial transport, and a military vehicle. But the technological challenges are significant, the costs high, and only the shuttle mission seems feasible.

PHOTOS: NASA-LANGLEY; BETTMANN NEWSPHOTOS

STEPHEN W. KORTHALS-ALTES has worked as a consultant to NASA and as an aerospace plane cost analyst for Rockwell International. He received master's degrees in both aerospace engineering and in technology policy from M.I.T. His joint master's thesis examines the feasibility of the aerospace plane.

Turbojets, found on most airliners, operate up to about Mach 3, or three times the speed of sound. A ramjet, the simplest of aircraft engines, operates from Mach 1 up to Mach 6. The air turbo-ramjet combines the technologies. A scramjet would begin to work only around Mach 4; its upper limit is unknown.



cost is likely to be six times the official estimate. The aerospace plane might be a viable alternative to the space shuttle, but its value as a civilian hypersonic transport or as a military aircraft is doubtful.

Nevertheless, in January 1986, a three-year, $700 million program to design an aerospace plane in detail began. Participating government agencies include the Defense Advanced Research Projects Agency (DARPA), NASA, the Air Force, the Navy, and the Strategic Defense Initiative Organization (SDIO). In April DARPA awarded two $27 million contracts for the preliminary design of a full-size revolutionary engine, a crucial element of the aerospace plane. One went to Pratt & Whitney, the other to General Electric. On the same day, DARPA awarded $7 million contracts for conceptual design of an airframe to Boeing, General Dynamics, Lockheed, McDonnell Douglas, and Rockwell International. The plan is that in 1989, after studying various applications and technology areas, DOD will decide whether to procure the plane.

Unproven Technology

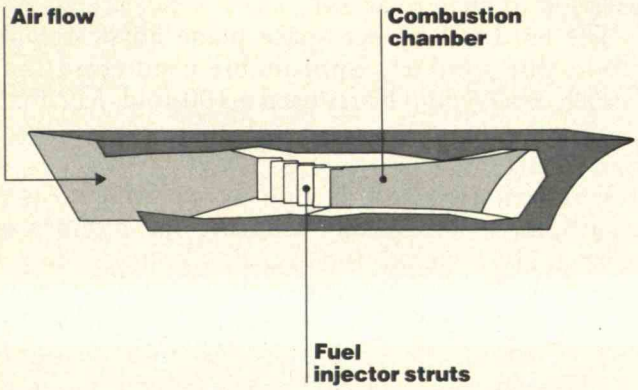
What makes the aerospace plane special is its intended use of fuel-efficient, air-breathing engines instead of relying exclusively on rockets to reach orbit. Seventy-five percent of the space shuttle's lift-off weight of 4.4 million pounds is propellant, and 83 percent of that propellant is oxygen. A launch vehicle carrying oxygen through the atmosphere is like a fish in the ocean carrying a canteen of water. The aerospace plane would rely on oxygen from the air up to an altitude of about 40 miles. Small rocket engines would take over for the final acceleration into orbit. The rockets would also be used for orbital maneuvering and for initiating re-entry.

The concept does impose some penalties. Designed to take advantage of atmospheric oxygen, the complex air-breathing engines would be heavier per pound of thrust than conventional rocket engines. One set of engines, either the air-breathing engines or the rocket engines, would always be dead weight. Furthermore, an aerospace plane would take off horizontally like an airplane, so to gain lift it would need a fuselage and wings, components that a vertically launched rocket does not have. Heavy-duty landing gear would be necessary to support the vehicle at take-off, when its weight would be nearly five times as great as at landing.

Propulsion is the technology that will make or break the plane. The entire underside of the airframe must serve as an extension of the air intake and nozzle of the engine because at hypersonic speeds (speeds higher than Mach 5, five times the speed of sound) very large engine airflows are required for adequate thrust. Eight to twelve engines, each about three feet across and ten to fifteen feet long, would be slung beneath the fuselage to ingest the compressed air of the shock wave the vehicle's nose would produce. Design changes in any part of the engine or airframe could require changes in all the other parts.

The engine that would propel the aerospace plane

Scramjet



at hypersonic speeds is still experimental. Moreover, this engine—the supersonic combustion ramjet or scramjet—is the only possible one for hypersonic flight. The reason is clear from a review of its technological ancestors, all of which share a basic principle: they produce thrust by expelling gases faster than they come in.

Turbojet engines are found on most airliners. Turbojets use a fan-like compressor to raise the temperature and pressure of the air before combustion. The burning gases expand, and as they escape, they power the turbine that drives the compressor. Turbojets reach their operating limit at about Mach 3. That's when the temperature of the gases turning the turbine reaches about 2,300 degrees F, the maximum today's turbine blades can sustain.

A ramjet is the simplest of aircraft engines. For compression, it relies on the so-called ram-pressure of the incoming air stream in a moving aircraft. Air enters the engine, slows down to subsonic speeds, mixes with the fuel, ignites, and escapes through the rear nozzle. Ramjets can't operate until the aircraft reaches about Mach 1, so some other form of propulsion brings the vehicle up to that speed. At about Mach 6, ramjets lose their effectiveness because the temperature in the combustion chamber becomes so high (nearly 2,700 degrees F) that the fuel is expelled before it can be completely burned. The partially burned fragments do not contribute their full energy to producing forward thrust.

The air turbo-ramjet (ATR) marries turbojet and ramjet technology. The Aerojet Co. conceived the ATR 37 years ago, but so far has only tested it in the laboratory. Up to Mach 2 this engine compresses incoming air mechanically, but between Mach 2 and Mach 6 it relies on ram-pressure. The crucial feature of the ATR is that the compressor turbine is driven by the fuel in gaseous form, not by the hot inlet airstream. The hot air is diverted around the turbine to mix with the fuel coming from the turbine. Then the mixture of fuel and air burns in a ramjet-style combustion chamber. However, at about Mach 6 the air entering the chamber slows down so rapidly that its temperature soars to about 3,000 degrees F, much as in a ramjet, so that even non-moving engine parts may fail from overheating.

A New Engine

A scramjet is very similar to a ramjet. The major difference is that while air slows down to subsonic speeds inside a ramjet, air maintains supersonic speeds throughout a scramjet. Engine heating is minimized since less of the air molecules' kinetic energy is converted to thermal energy.

The greatest problem is that burning fuel in a supersonic flow is equivalent to lighting a match in a hurricane. At Mach 7 a fuel particle has less than a millisecond to ignite before it is swept out the exhaust. Traditional jet fuels, like kerosene, do not ignite quickly enough. Only hydrogen will work, and hydrogen's low density necessitates fuel tanks five times as large as hydrocarbon fuel tanks.

Scramjets would circulate liquid hydrogen through the engine and airframe to help dissipate the intense heat generated by hypersonic flight. Conventional ramjets inject fuel from the engine walls, but a scramjet's short mixing time requires fuel injectors on struts that span the air inlet. Cooling these struts would be especially important. According to NASA researchers, the scramjet fuel-injection struts also present the most formidable structural problems of the aerospace plane. The struts must withstand both shock waves within the engine and the thermal stresses resulting from two temperature extremes (−375 degrees F inside the struts and 1,700 degrees F outside).

Scramjets would begin to work only at speeds above Mach 4, twice as fast as the Concorde flies. Air turbo-ramjets would get the aerospace plane up to Mach 4. Estimates of the top speed these engines could attain vary from Mach 10 to orbital velocity—

DIAGRAMS: OMNIGRAPHICS

Several countries in additon to the United States are working on versions of an aerospace plane.

Britain may spend $6 billion to develop the unmanned HOTOL (horizontal take-off and landing).

Mach 25. Wind-tunnel experiments show that scramjets can operate to at least Mach 7, the limit of NASA's current test facilities.

As speeds increase, the percentage difference between the inlet airstream velocity and the exhaust gas velocity becomes smaller, so even slight engine inefficiencies could cancel the vehicle's thrust. Inefficiencies in the scramjet inlet or nozzle would have major consequences. Also, even if efficiencies could be completely eliminated, the scramjet's performance would decline significantly as speeds increase. In contrast, a rocket engine's performance remains constant. By Mach 20, a scramjet would have only a slight advantage over a rocket engine.

The exact speed at which scramjets quit may determine whether the aerospace plane is feasible. The earlier the switch from scramjet to rocket thrust, the more liquid oxygen the aerospace plane would have to carry. Supporters of the aerospace plane claim that it would be a launch vehicle the size and weight of a conventional aircraft, but my analysis says that the plane will live up to this claim only if scramjets can function up to around Mach 17.

Underestimated Costs

The government does not seem to have a reliable basis for the statement that it would cost $3 billion to develop an aerospace plane. Christopher Demisch, an aerospace analyst at the First Boston Corp., estimates the financial requirements to be roughly the same as the shuttle's: about $14 billion.

British Aerospace, Ltd., is working on its own aerospace plane called HOTOL (short for horizontal take-off and landing). They estimate the development costs to be about $6 billion, even though HOTOL's baseline design calls for a smaller, less complex, unmanned vehicle.

Even a subsonic aircraft costs between $2 billion and $3 billion to develop. The congressional Office of Technology Assessment has said that an American supersonic transport (SST) would cost $6 billion to $8 billion, and Ford invested $3 billion to develop the Taurus.

My own analysis of aerospace plane development, fabrication, and operating costs uses a cost-estimating model developed by the European Space Agency. I have concluded that the total cost would come to about $17 billion. The cost-estimating equations, based primarily on weight, are derived from component costs of past U.S. and European launch vehicles, as well as from proposed designs for advanced launch vehicles. Scramjet and ATR cost estimates use a method developed for the Federal Aviation Administration to analyze an SST.

The hard sell by aerospace plane advocates includes the similarly improbable prediction that launch costs would be reduced a 100-fold. My analysis suggests that it is more realistic to expect a ten-fold reduction.

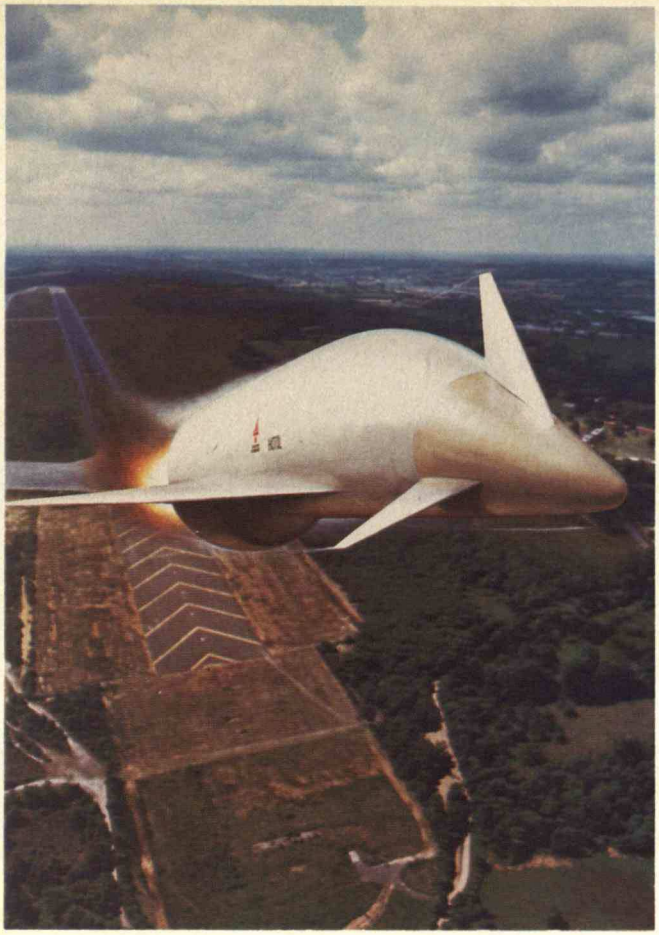
Furthermore, any reduction in operating costs is contingent on drastically reducing the number of technicians required for launch. A space shuttle launch is very labor-intensive, with launch personnel, maintenance, and crew training accounting for 46 percent of operating costs. All told, a shuttle launch requires some 6,000 people. Even if the aerospace plane really could reduce launch costs a 100-fold, it would be because of revolutionary progress in collateral technologies such as highly automated systems for checking out the readiness of a vehicle for launch; long-life or maintenance-free subsystems; and facilities for servicing a launch vehicle horizontally rather than vertically.

Such improvements could be applied to any new launch vehicle to make it more attractive. This illustrates one of the deficiencies in arguments for the aerospace plane: comparing the vehicle with the space shuttle. The aerospace plane appears superior, but any competition between 1973 technology and projected 1990s technology is useless. A space shuttle built today with the latest composite materials would save over 15,000 pounds.

The Aerospace Plane as a Launch Vehicle

Because three separate applications are proposed for the aerospace plane, the feasibility of each must be considered.

The vehicle may be best suited to place payloads into a low-earth orbit at relatively low cost. But the idea of replacing the shuttle with the aerospace plane puts NASA in a delicate situation. The prospect of such a plane excites many NASA engineers, and since it is Reagan Administration policy to push the plane, NASA supports it publicly. At the same time, NASA officials fear that too much talk about the aerospace plane would suggest they were giving up on the shuttle. When the shuttle program is back on track, the agency may be less reticent about discussing its plans



and more free to promote the aerospace plane.

However, NASA is not monolithic. The internal debate within the agency about the best option for a next-generation launch vehicle is not over. Ivan Bekey, NASA's director of advanced programs, has said his studies indicate that a new kind of vertically launched rocket might be just as promising as the aerospace plane. This rocket would carry its own oxygen, but it would employ dual-fuel engines that burn kerosene in the lower atmosphere and hydrogen in the upper atmosphere and outer space. Like the aerospace plane, the dual-fuel rocket would need advanced, lightweight structural materials as well as a vastly simplified launch environment.

Charles Eldred, assistant head of the vehicle analysis branch of NASA-Langley's Space Systems Division, has evaluated both conventional (vertical take-off, all-rocket propulsion) and unconventional (horizontal take-off, air-breathing propulsion) launch-vehicle concepts. He concludes that advanced rockets would be smaller, lighter, less complex, cheaper, and lower in technological risks.

Of course, considering the secrecy shrouding the aerospace plane, it is possible that DOD researchers have made key advances, unknown to their civilian counterparts, that make the concept superior to its rivals. Rumors have circulated that DOD is on the verge of producing a scramjet able to operate in extremely thin air. If true, this would extend the top speed at which a scramjet could operate.

The Aerospace Plane as a Hypersonic Transport

Government and industry planners—including officials from NASA-Langley, the Commerce Department, and McDonnell Douglas—are investigating the feasibility of applying air turbo-ramjets and scramjets to civilian aircraft. The intent is to improve air transportation, especially to nations in the Pacific Rim—hence the nickname "Orient Express." The Orient Express would be a 300-to-500-passenger, Mach 5 HST able to fly from New York to Beijing in about two hours. The vehicle, which would probably be powered by a methane-fueled ATR, would benefit from aerospace plane technology.

The logical way to begin appraising an HST is by examining its stillborn cousin, the SST. In 1971 Congress killed the U.S. SST program, citing the dubious prospect of commercial success, probable airport noise and sonic-boom problems, possible negative effects on ozone and climate, and the impropriety of spending large sums of public money on a project to benefit only a few people. These same questions will inevitably come up for the HST.

Take, for example, Congress's fears about profitability. They are borne out by the Anglo-French Concorde, which, though a technological achievement, is a financial disaster. A viable HST program would need convincing, favorable economic projections supported by both government and the aerospace industry.

However, many industry officials see the HST as strictly a military program. "This whole idea of a hypersonic airplane is good from a military standpoint, but is being way overplayed as an Orient Express," asserts John Steiner, who was a vice-president of Boeing for 22 years. He recently chaired the White House Aeronautical Policy Review Committee. Steiner favors a second-generation supersonic transport because airlines would be willing to invest in it. He says that at a time when many airlines are struggling just to stay out of the red, talk about developing an entirely new fuel system based on either hydrogen or methane is "baloney."

Evidently there are those on the other side of the Atlantic who agree with Steiner. France's Aerospatiale, Ltd., is busy designing a Mach 3 successor to the Mach 2 Concorde. Speaking of the HST, one

PHOTO: ARTHUR GIBSON/BRITISH AEROSPACE

Aerospatiale official has remarked, "Does this mean airlines are going to qualify passengers for space flight in order to carry them in these technological marvels?" He adds, "We French often are accused of going off with our heads in the clouds on new ideas, but I think in this case it is we that have our feet on the ground while our American friends are doing the daydreaming."

The HST would almost certainly be too expensive and too risky to develop in the face of a competing second-generation SST from France. The French already have an extensive technology base in supersonic-transport design, so the project lends itself to international cooperation, a stated goal of U.S. civilian aerospace policy. The French have expressed interest in such cooperation. However, because the HST and the highly classified aerospace plane share technology, cooperation appears a long way off.

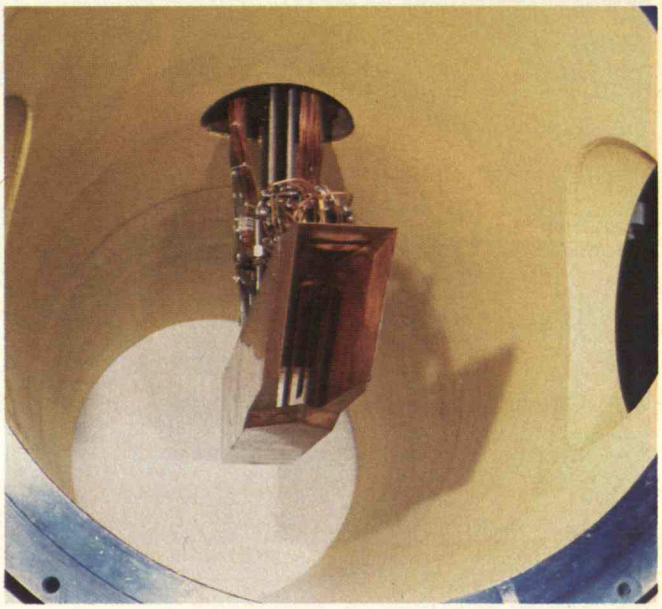
No matter what U.S. aerospace officials think of the HST, few criticize the plan publicly, in case the government decides to go ahead with it. This has produced some amusing arguments in favor of the HST. Lockheed justified the plane to the House Committee on Science and Technology on the basis of "the nominal comfort limit of passengers," which is three hours. "To extend beyond the three-hour limit, services such as meals and entertainment must be provided to entertain passengers," Lockheed's representatives said. "These services cost fixed weight, add crew members, and are expensive in themselves." It strains the imagination to think that the cost and weight of sandwiches, soda, and videotaped movies justify a multi-billion-dollar development project.

The Aerospace Plane as a Military Vehicle

The military is extremely tight-lipped about the aerospace plane. Contractors have been ordered not to discuss the project, and NASA officials have been chastised for providing overly realistic concept drawings. Because of the secrecy, it is unclear what applications the military is considering.

Yet as recently as 1983, Robert S. Cooper, former DARPA director, told Congress that "currently defense has no mission for a hypersonic aircraft." At the same hearing, retired Brigadier General Charles E. Yeager, a staunch advocate of the Orient Express, admitted that while the military is interested in researching hypersonic aircraft, it is not quite sure

Below: The supersonic combustion ramjet—or scramjet—undergoes tests. This kind of engine is crucial in developing an aerospace plane. Right: A researcher uses NASA-Langley's Mach 6 wind tunnel, the largest now available. Even larger facilities will be needed to test an aerospace plane since it would fly at up to Mach 25.



what it would do with one. Hans Mark, deputy administrator of NASA, stated that an aerospace plane might be useful for the Strategic Defense Initiative (SDI), but qualified his remark: "We are not at the stage in the hypersonic area where there are any missions that one can hang a program on. . . . I thoroughly agree with General Yeager there when you asked him the question whether there were missions for hypersonic vehicles. The answer right now is no."

Because the Department of Defense is reluctant—or unable—to specify missions for an aerospace plane, analyzing military applications is difficult. Some possibilities include tactical air defense, strategic reconnaissance, strategic offense, strategic defense, and space combat.

Tactical air defense of civilian and military installations requires vehicles that can take off quickly. Such vehicles would use long-range missiles or cannon fire to locate and destroy enemy cruise missiles and aircraft. The high speed of the aerospace plane would not be much of an advantage, since F-15s can be forward-based in Great Britain, West Germany, Greenland, Spain, and the Azores. Moreover, as Cooper said, "Aircraft ultimately end up in their final throes of engagement with one another in subsonic regimes. And so supersonic aircraft beyond about Mach 2 are probably of little or no utility for the military." He added that missiles can be used above Mach 2.

Nor does the aerospace plane appear to be the most cost-effective air defense system. My calculations indicate that the aerospace plane configured as a launch vehicle would cost about $1 billion per vehicle. Configured as a tactically equipped, hypersonic fighter plane, it would cost less, but F-15s cost only about $27 million. The Air Force has said it would not build another plane, the Advanced Tactical Fighter (ATF), if it ends up costing more than $40 million a copy.

Designing an aerospace plane for reconnaissance would be a special challenge since integrating a camera system into the vehicle's fuselage would further complicate already formidable thermal-protection and aerodynamic problems. Military reconnaissance currently employs both sophisticated satellite systems (KH-11 and Big Bird) and high-altitude, high-speed aircraft (primarily the SR-71). Satellites are said to provide the best resolution, but the SR-71, able to cruise at Mach 3 at 86,000 feet, can map over 100,000 square miles in less than an hour.

An aerospace plane configured as a reconnaissance aircraft would cover an area between those of the SR-71 aircraft and the KH-11 satellites. Thus it appears that any reconnaissance the aerospace plane might provide could also be obtained using the KH-11 or the SR-71.

Another possible military use is strategic offense—that is, delivering nuclear weapons. The aerospace plane's potentially high speed and wide operating envelope could increase the probability of penetrating enemy air defenses. However, to ensure that a Soviet first strike could not destroy aerospace planes on the ground, they would have to be able to take off 15 minutes after being alerted. Strategic bombers can take off this fast, but they do not face the problems of storing liquid hydrogen.

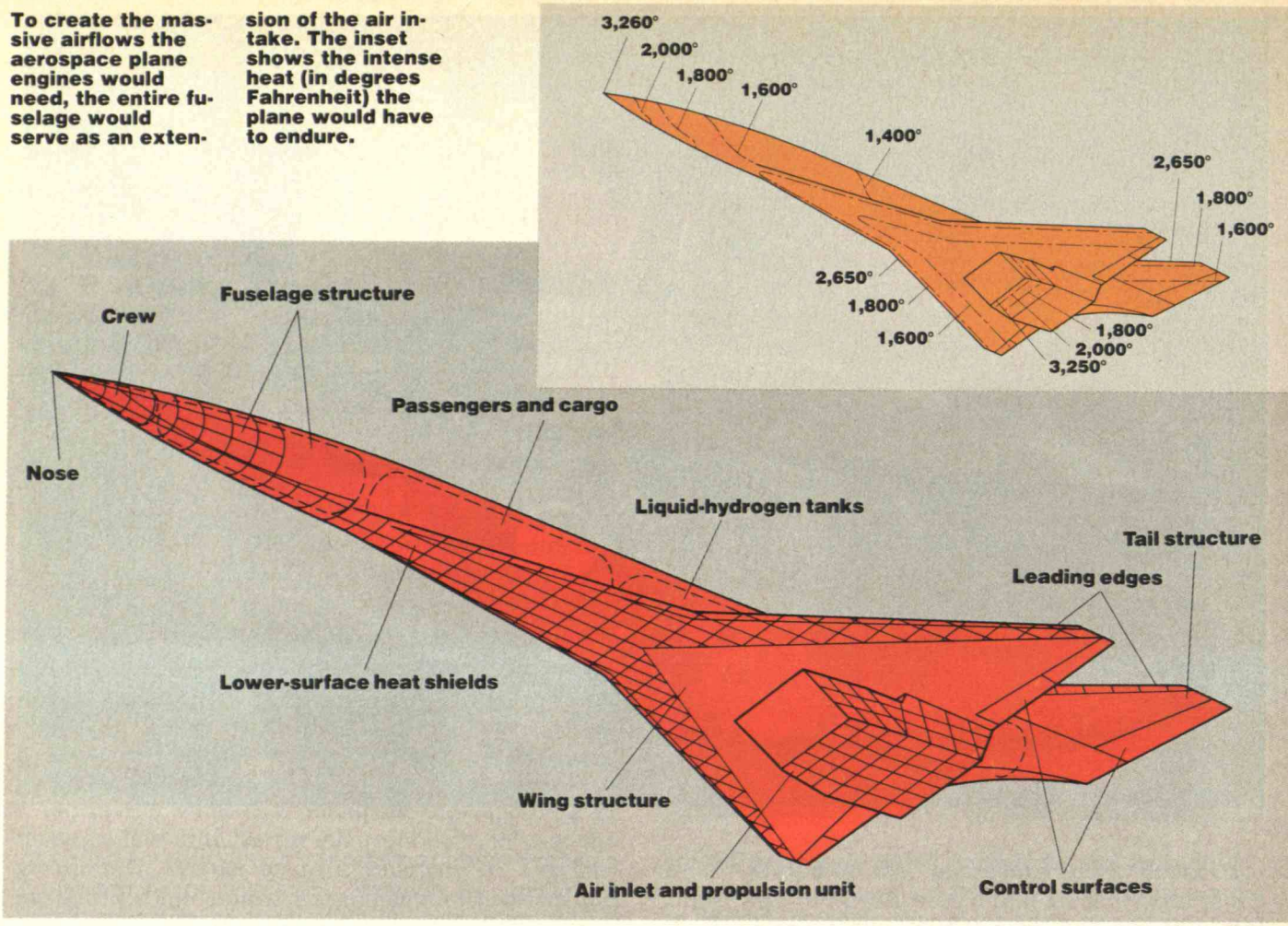
Again, cost-effectiveness must be considered. An MX missile, carrying 10 warheads, costs about $50 million to $100 million—5 to 10 percent of the cost of the aerospace plane as a launch vehicle. The projected aerospace plane payload could accommodate approximately 30 warheads—the equivalent of only three MX missiles.

Hans Mark once suggested a strategic defense role for the plane in intercepting ballistic missiles in flight. There are two main problems with this idea. First, the plane would need to react almost instantaneously and accelerate at rates a human could not tolerate. Second, even if an aerospace plane with suitable weapons were in orbit at the time of attack, the missiles would be so dispersed that very few could be intercepted during the 20-minute coast phase.

Finally, some people have suggested a space-combat function for the aerospace plane—either offensively, to destroy enemy space assets, or defensively, to protect our space systems.

The defensive role does not appear feasible for several reasons. Our aerospace plane would be manned, while its target, a Soviet anti-satellite

PHOTOS: NASA-LANGLEY



To create the massive airflows the aerospace plane engines would need, the entire fuselage would serve as an extension of the air intake. The inset shows the intense heat (in degrees Fahrenheit) the plane would have to endure.

weapon (ASAT), would be unmanned and thus able to travel faster. The current Soviet ASAT takes three hours to hit a target, but if the United States proceeds with a military aerospace plane, the Soviets could develop a faster ASAT. The U.S. ASAT takes only a few minutes to destroy its target.

In an offensive role, the aerospace plane would be just another ASAT. Paul Czysz, McDonnell Douglas's aerospace plane program manager, thinks the vehicle could neutralize selected enemy space assets without being detected. He offers two examples: an aerospace plane might fire needle-like projectiles into an enemy tracking and fire-control radar to overwhelm the antennae, or it might use low-intensity lasers to "blind" satellite sensors.

However, disabling a satellite with an aerospace plane does not appear to offer any advantages over destroying it with existing ASATs. In addition, satellite sabotage, as described by Czysz, would not be covert since Soviet space-tracking radar would easily detect an aerospace plane.

Why Is the Aerospace Plane Being Pushed?

Only three years ago civilian and military experts testified before Congress that they had no missions for hypersonic aircraft. Now hypersonics are the rage in NASA and DOD, and the president has endorsed the aerospace plane.

Technological progress and the economic incentives of reduced launch costs are ostensibly the reasons behind the decision to proceed with the program. But political factors may be overshadowing the technical and economic arguments.

Aerospace plane support in the executive branch comes from the top. Reagan's backing may result partly from his keen interest in the space program. He has twice before endorsed sizable space plans in State of the Union addresses. In 1983 it was SDI and in 1984, the space station, but both proposals met substantial criticism. Some speculate that the president wishes to be remembered for a landmark contribution to the space program, much as Kennedy is remembered for challenging NASA to put a man on the moon before 1970.

Reagan may also be motivated by the importance he attaches to SDI. Officials in SDIO readily admit that they are leaders in the push for an aerospace plane. The projected development and production costs of SDI's infrastructure alone are alarmingly high. With launch costs at today's rates added in, the figure becomes colossal, so SDIO officials stress

DIAGRAMS: HANK IKEN/SCIENTIFIC AMERICAN

VEHICLE	DEVELOPMENT COST
Subsonic aircraft	$2–3 billion
Ford Taurus	$3 billion
British HOTOL	$6 billion
American SST	$6–8 billion
Space shuttle	$14 billion
Aerospace plane (Air force estimate)	$3 billion
Aerospace plane (First Boston estimate)	$14 billion
Aerospace plane (M.I.T. estimate)	$17 billion

the need to reduce those costs by "an order of magnitude." The current baseline SDI architecture calls for 50 million pounds to be orbited at a total launch cost of $130 billion. While the aerospace plane may greatly benefit the SDI program, it can be sold as a civilian aircraft. This would appease a public generally supportive of the space program but increasingly concerned about the "militarization of space."

Regardless of military applications, the Air Force has its own reasons to promote the aerospace plane: the vehicle would loosen NASA's monopoly on manned space flight. The Air Force has long sought independent access to space.

Even NASA has its own reasons to promote the aerospace plane. The vertically launched rocket described by Bekey and Eldred might be more economical, but it lacks "political sexiness." On the other hand, the aerospace plane arouses interest in almost everyone who hears about it and may be an easier concept to sell.

A Plane Without a Mission

In short, the aerospace plane is being oversold. It is expecting too much to believe that the plane would combine the vantage point of a reconnaissance satellite with the maneuverability of an SR-71, deliver the ordnance of a bomber with the speed of an ICBM, launch payloads into orbit with the ease of a DC-9, and whisk civilian passengers across oceans in a few hours. The futuristic vehicle's feasibility is critically dependent on scramjet engines performing over the most optimistic operating range. Moreover, aerospace plane development, fabrication, and operating costs are all likely to be significantly higher than advertised.

Also, the aerospace plane is most definitely a military program: 80 percent of the funding comes from DOD and 20 percent from NASA. This creates two main problems. First, while much of today's civilian aviation technology can trace its roots back to military programs, the research orientation of NASA and the procurement orientation of DOD conflict. Military requirements may hasten prototype development at the expense of basic research that would make the vehicle cheaper or better.

Second, the organization that contributes the most money to a project usually has the biggest say in the direction it takes. The factors that drive technology for military applications are very different from those which drive technology for commercial applications. Military specifications stress specific operational objectives. Commercial developments tend to emphasize operating efficiency, safety, reduced production costs, and high availability with low maintenance.

This country needs a sensible alternative to the space shuttle, but we must be wary of repeating the mistakes of the past. Perhaps the most important lesson of the shuttle is that a space vehicle designed to perform many functions is optimal for none. Some form of an aerospace plane could drastically reduce the cost of a launch, but this objective must be explicitly made priority number one. This will not happen by itself and it will not happen without giving precedence to civilian applications over military ones.

Preeminence in aeronautics depends on technical excellence and clear-cut cost advantages. A low-cost, low-noise, fuel-efficient vertical take-off and landing vehicle for use in urban areas might be an even greater boon to civilian air travel than a hypersonic aircraft. Likewise, the military's desire for a hypersonic interceptor must be balanced against the need for maneuverable, maintainable, and fuel-efficient aircraft. We must avoid the trap of thinking that higher and faster is necessarily better. □

Extending "user friendliness" to accommodate the needs of disabled individuals will make computers more convenient for everyone.

Making Computers Accessible to Disabled People

BY FRANK BOWE

In Fairfax, Va., Rick Pilgrim, who has a spinal-cord injury that prevents him from moving even his head, works as a systems analyst for the National Institutes of Health. Thirty miles away, Kevin Riley, who has a similar injury, works as a programmer for IBM. Telecommuting—using a modem-equipped personal computer in the home to receive, process, and send information back to the workplace—promises to allow severely disabled individuals to work at demanding jobs. These same technologies can permit severely disabled children to "go to school" without leaving their homes. Speech synthesizers that read print and instantly transform it to speech now give people who are blind or have dyslexia access to worlds of information previously unavailable.

However, a major problem remains before computer technology can fulfill its promise of allowing people to overcome the limitations of severe physical handicaps and learning disabilities. The technology must be designed to be fully accessible to—that is, easily usable by—people who are handicapped. Today computers are not set up to accommodate the input and output devices that many disabled people require. This means that special keyboards and other aids often require custom solutions for use with each computer, making the devices expensive and limiting their availability. If options for different users were incorporated into the design of all computers, the lives of millions of disabled individuals could be greatly enhanced.

The concept of accessibility is most familiar in the design of buildings. We see accessible architecture in the form of automatic doors and entrances level with exterior landscaping in airports, at hotels, on college campuses, and in libraries. These designs seem natural to us: they do not look as though they were created specifically for individuals who are handicapped. Most people do recognize ramps and lifts, lowered public telephones and drinking fountains, Brailled elevator buttons, and bathroom grab bars as designs with a special purpose. But whether striking or unobtrusive, architectural accessibility has opened up hundreds of thousands of buildings to use by people with disabilities.

What is startling is how recent all these changes are. Congress did not enforce a requirement that federal buildings be accessible until it passed the Rehabilitation Act of 1973, and the government did not extend the requirement to structures erected with federal grant monies until 1977. Each step was actively opposed by many architects who believed that the requirements would detract from the aesthetics of their designs, by builders who feared higher construction costs, and by universities and other institutions that insisted they could not afford to retrofit their buildings. Indeed, the American Council on Education fought the act for almost a year. Said University of Missouri vice-president A.G. Unklesbay in disgust: "This law requires us to spend untold millions to prepare facilities that almost certainly

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PHOTO: ENRICO FERORELLI/DOT

A language-disabled six-year-old gestures triumphantly after a talking word processor repeats aloud what he has typed. Enabling all word processors to provide speech as well as print output would benefit millions of handicapped children and adults.

Accessible buildings are so convenient that architects have a hard time explaining why they have not always built that way.

will never be used." But despite such opposition, the concept of accessibility has now become an accepted tenet of architecture.

Quiet persuasion, militant protest, and litigation by people who are disabled, as well as an altruistic desire to assist handicapped individuals on the part of others, have helped architectural accessibility gain acceptance fairly quickly. Yet progress would undoubtedly have been much slower had not the concept proven valuable to people who are not handicapped. For each wheelchair user who traverses a ramp, ten other people without disabilities also take advantage of it: parents with baby carriages, bicycle riders, furniture movers, and pedestrians who simply find it easier to walk up a ramp than to climb stairs. In fact, easier access to buildings is so convenient for everyone that architects and engineers have a hard time explaining why they did not always build this way.

Even the issue of costs has sometimes worked to the advantage of those who have complied with the new laws. When university enrollments began to sag in the early 1980s as the "baby bust" generation came of college age, college chancellors discovered with delight that the changes they had made so reluctantly turned out to be critical in attracting the large, previously untapped population of disabled students. Today the American Council on Education estimates that 7.4 percent of the nation's 1.6 million college freshmen are disabled, up from 2.6 percent in 1976. One-half million handicapped students now attend colleges and universities as a direct result of the enhanced accessibility of buildings and facilities.

Efforts to make information technologies more usable by and affordable to people who are disabled would have a similar effect. Such efforts would not only allow a major segment of our society to communicate more easily and participate fully in productive work but would also benefit all other users as well.

Disability Is Universal

Disability is something that happens to people in the normal course of their lives. On one level, we all know that: our grandparents lose vision, hearing, and manual dexterity as they age. Yet exposure to telethons that focus on handicapped children leads people to believe that disability is most often something "those people are born with." This is a myth we must explode: five of every six disabled individuals become impaired during their working or retirement years. In other words, anyone can become disabled at any time, and most of us become temporarily disabled at some point during our lives.

In the United States, about 36 million of some 240 million people have disabilities. About half of Americans 75 and over are handicapped, usually with vision and hearing impairments. Almost three in ten Americans aged 65 to 74 are disabled. One-tenth of the school-age population—4 million children—is disabled. And about 13 million persons of working age (16 to 64) are handicapped, or one in eight.

Because ramps and lifts have become so prevalent, people often assume that physical disabilities are the most common. Yet only about 500,000 Americans use wheelchairs. In contrast, some 8 million Americans of all ages have learning disabilities, including dyslexia, an impairment that interferes with reading the printed word. Dyslexia is undiagnosed in many adults and is a major factor contributing to illiteracy.

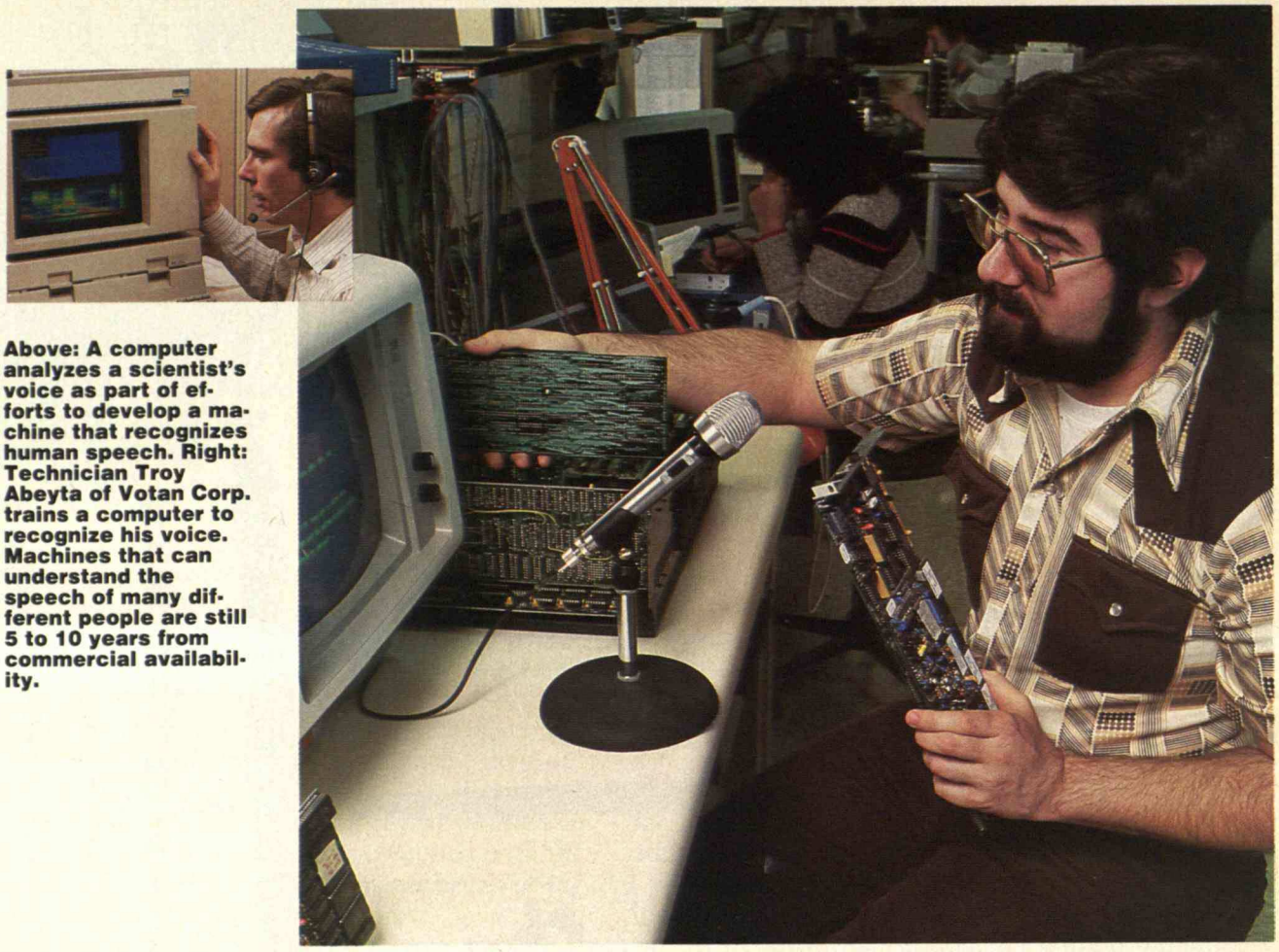
A total of 6.5 million Americans do have restricted mobility in their upper and/or lower limbs, often caused by arthritis. Another 3.5 million individuals have disorders of the central nervous system, including cerebral palsy, muscular dystrophy, multiple sclerosis, paraplegia, and quadriplegia. Some 6 million people are seriously hearing-impaired, including 2 million who are deaf. About 5 million Americans are retarded, and some 2 million are severely mentally ill, usually from schizophrenia or psychosis. Just under 1.7 million people have poor vision or are legally blind. And about 1 million have epileptic conditions that cause periodic seizures.

The most common handicaps among children and youth are learning disabilities and mental retardation; impaired mobility affects just 150,000 school-age children. Many children have speech disorders owing to hearing loss, cerebral palsy, or other conditions, but deafness and blindness are relatively rare until people reach advanced age.

Another popular assumption about disabled individuals is that the government "takes care of those people." However, only 2 million handicapped Americans of all ages live in institutions. Like many other attitudes toward disability, this one has its roots in truth: institutionalization was a common response to disability until the late 1970s. Indeed, the United States historically preferred to keep disabled individuals out of sight: the 13 colonies for-

Despite widespread opposition, accessibility has become an accepted tenet of architecture. College chancellors have even found that they can shore up sagging enrollments by tapping the large number of disabled students who now can gain access to campus buildings.

PHOTOS: ADAPTIVE ENVIRONMENTS



Above: A computer analyzes a scientist's voice as part of efforts to develop a machine that recognizes human speech. Right: Technician Troy Abeyta of Votan Corp. trains a computer to recognize his voice. Machines that can understand the speech of many different people are still 5 to 10 years from commercial availability.

bade them to immigrate unless relatives or others agreed to assume full responsibility for their care. Later, large hospitals for disabled people were erected, mostly in rural areas far removed from central communities.

The idea of deinstitutionalization gained momentum as disabled individuals demanded to become part of mainstream society and the costs of institutional care soared (they now average more than $85,000 per year). Today the vast majority of disabled people lives in the community. More than half resides in private homes or apartments with spouses, another 25 percent lives with other family members, and one in twelve lives alone. Only about 5 percent of disabled individuals lives in hospitals, nursing homes, or other institutional settings.

The Retrofit Solution

The architects who built America's cities were not concerned about making them accessible, since disabled people would not be living in and using the facilities. Similarly, there was no apparent reason for engineers to extend the concept of accessibility to sophisticated machinery in the mid-1970s, when high technology remained the preserve of the few. So in technology we have repeated the pattern we followed in architecture: we have designed for people with full possession of their faculties, only to discover later that we had inadvertently excluded large numbers of disabled individuals.

When Congress first passed the Rehabilitation Act, computers were still obscure and frightening machines for most Americans. These room-sized contraptions were kept in locked areas, attended by professional programmers, and intolerant of even slight errors on data-entry cards. The Apple II personal computer appeared just about the time handicapped activists stormed the U.S. Department of Health, Education, and Welfare in April of 1977 to demand enforcement of the act passed four years earlier. Yet not until 1980 and 1981, when the Apple IIe and the IBM PC were introduced, did the idea that the computer could become a commodity for the masses take hold. Dramatically lowered costs were largely the reason for the change, but so, too, was the blossoming idea of "user friendliness": that computer hardware and software could be designed specifically for non-programmers.

People with disabilities were quick to grasp the

PHOTOS: CYNTHIA CHARLES/GAMMA LIASON

When Drexel University required every freshman to buy a Macintosh, it was sending a message that "no blind person need apply."

potential of the personal computer to help them surmount the obstacles of everyday life. In Fort Wayne, Ind., after a motorcycle accident left him blind, Bill Grimm wrote special software that linked an Apple IIe to a small speech synthesizer that read aloud the text on his computer screen. In Shreve, Ohio, Barry Romich built extra-large keyboards so friends with cerebral palsy could use IBM PCs to write. And in Rockville, Md., John Yeh wrote machine code allowing him to use the telephone despite his deafness.

These were all retrofit solutions, or "patches" in computer jargon—analogous to placing wooden ramps beside stairs. Custom-designed alterations were expensive, and the number of people who could afford the technologies was limited.

Some computer technologies designed to help people who are disabled have since become more affordable and therefore come into more common use. For example, speech synthesizers, some now selling for as little as $100, can convert many kinds of text to artificial speech. Personal computers can also be equipped with software that translates from English to Braille for printing. But even these advances have their limitations. Most popular word-processing and business software uses the PC operating system in a way that prevents a speech synthesizer from capturing the output. Thus, many blind and dyslexic individuals are restricted to software designed specifically to be used with a speech synthesizer, reducing the choice from tens of thousands of programs to a few dozen. Moreover, most synthesizers cannot read pictorial symbols (or icons) and graphics.

People with conditions that limit finger mobility, such as cerebral palsy, quadriplegia, and severe arthritis, can use a light pen, joystick, or large keyboard to give the computer commands. Again, however, such keyboard substitutes work with very few commercial programs. Moreover, to make the computer think that input is coming from the standard keyboard, an "emulator" must be attached between the keyboard and the operating system. The emulator has to be custom-designed for each of the many PC models, including those produced by the same company, because there is no standard configuration now in use. The situation is similar to that of a remote-control device for a TV. Viewers can change channels by touching keys or using the remote control; an emulator in the TV allows it to respond to both kinds of input. Yet the remote-control unit cannot be used with a set of a different model. The retrofit solution helps, but it doesn't help enough.

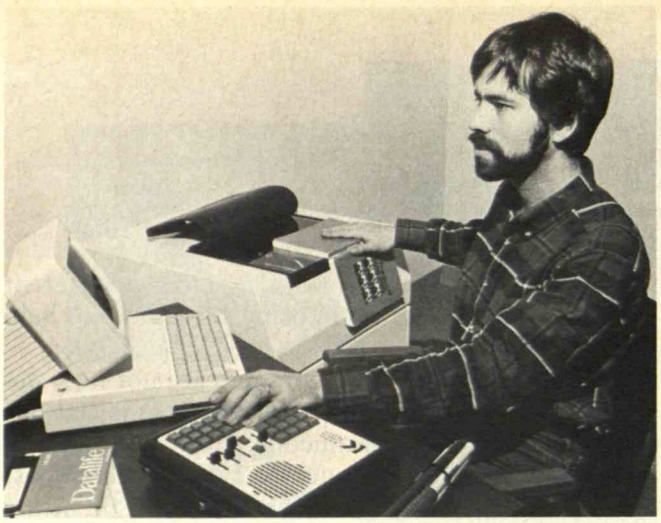
Furthermore, because computers are not now designed to accommodate special needs, adaptations such as those allowing someone with cerebral palsy to use a PC can cost as much as $20,000. That cost could drop significantly if the problems of fitting different components together did not require custom solutions.

In some cases, educators have created problems by needlessly designing software to teach some disabled children at the expense of others. Some of this software is excellent, and most is readily affordable by schools. For example, talking software teaches blind children to count, and touchpads enable children with cerebral palsy to answer questions posed on the screen. But these one-dimensional changes create barriers for other disabled students: deaf children cannot hear the talking programs. The new aids also sometimes help keep handicapped children segregated from other children. That effect runs counter to the mandate of federal law, which requires schools to integrate disabled children into regular classrooms whenever possible.

Some problems with inaccessible technology occur because decision makers don't understand the consequences of their decisions. When Drexel University in Philadelphia required all its freshmen to purchase Macintosh computers, the school apparently did not realize it was sending the message that "no blind person need apply here"—a move of questionable legality. The original Macintosh required the use of icons, which voice synthesizers cannot read. The Macintosh also used a mouse input device, which blind people cannot point effectively. Had the university chosen another machine without those restrictions, such as the IBM PC or a compatible, these problems would not have arisen. Apple has redesigned the Mac to permit keyboard entry of commands previously available only by mouse, and is doing research on the problem of enabling voice synthesizers to read icons. But such products are not yet on the market, and Drexel's action erected barriers to the disabled that need never have existed.

Designing for Access

How does one design hardware and software to be more easily usable by people with disabilities? The



Above left: A Kurzweil reading machine translates a book into speech. The blind operator can control the speed of the sound using the keyboard at his left. The reading machine can also be linked to a computer for storing the text and printing it out in Braille.
Above right: A speech synthesizer pronounces everything a blind computer user calls up or types so that he can review the information and correct mistakes. The Versabraille at his right can store what he is typing and translate it into Braille, which he reads using the buttons under his fingers.

key concept is "transparency"—designing the parts of the PC to work together smoothly without the need for artificial aids. For example, the operating system of a transparent PC might not need an emulator because it would not distinguish between input from a keyboard and that from a joystick or other device. Users could therefore adopt whatever format for the machine that most suited their needs. Nor would the PC and its software "know" that the output was going to a voice synthesizer instead of a screen. This capacity would allow people needing a synthesizer to choose any software on the market.

The second critical idea is "redundancy": designing hardware and software to provide output simultaneously to both the screen and synthetic speech at the user's option. If a software package throws up icons onto the screen, it should provide text as well. The text might be hidden until someone blind or dyslexic asks for it, but it would be available. Redundancy would allow users to choose how they want to use a system, while transparency would allow the hardware and software to work together smoothly with any option.

The third requirement is to ease physical access to machines. There is no good reason, for example, for locating on/off switches at the rear of a PC. There is no excuse for requiring users to press two keys simultaneously to activate a command when the keyboard and software can just as easily be designed to accept sequential keying.

These three concepts apply not only to PCs but to copiers, printers, telephones, and other technologies as well. The idea is to acknowledge the fact that different people have different needs. IBM and Xerox discovered the importance of this concept when they tried selling their big copiers in Japan: few companies wanted to buy them because they were too high and their controls were located toward the back. Like Americans using wheelchairs, Japanese of short stature couldn't reach the controls. The retrofit solution? The U.S. companies suggested that the Japanese use stools. Of course, the better solution would have been to lower the control panel.

AT&T has offered redundancy as a solution to disabled people who are not dextrous enough to use coin telephones. An individual dials "O," says the word "special," and is connected to an operator who charges the call to the person's credit card. Newer phones are more obviously redundant: users can insert their credit cards directly, bypassing the coin slots altogether. Entrex Electronics even introduced a telephone in 1984 that permits users to "answer" simply by saying "phone": the unit behaves exactly as if the user had lifted the receiver.

In California, Steven Wozniak, co-founder of Apple Computer and now president of a company called Cloud Nine, is trying to build transparency into remote-control devices so they will function with any television, stereo, or compact-disc player. It's an exciting and potentially far-reaching advance in making technologies accessible.

The Prognosis

What are the chances that we will make our technologies as accessible as our buildings? In architecture, nothing much happened until the government made accessibility a requirement in state- and federally assisted projects.

The Rehabilitation Act of 1973 could be used to mandate that government-assisted employers provide accessible technology. Section 504 requires any

If federal agencies bought only accessible computers, the effect on the technology would be dramatic.

program or activity that receives federal grants to provide access for disabled people that is "equally effective" to that offered to nondisabled individuals. Section 504 also requires programs receiving federal aid to supply "auxiliary aids" so that individuals who are disabled may participate. Some lawyers argue that Congress did not intend to include personal computers, which had not even been invented in 1973, in the law's purview. Litigation will be needed to resolve that question, but none is now pending.

Section 501 of the same act requires federal agencies to make "reasonable accommodations," including providing equipment and other assistance, to disabled employees so they can perform work for which they are qualified. And in Section 503, Congress mandated that the federal government's 30,000 prime contractors and 75,000 subcontractors take affirmative action and make reasonable accommodations in hiring disabled employees. But it is unclear whether these provisions mean that agencies and private employers must purchase technology that is specifically designed to accommodate the needs of handicapped workers.

When Congress reauthorized the Rehabilitation Act in October 1986, it did call upon the General Services Administration (GSA) to develop guidelines for all federal agencies in purchasing accessible PCs and other office automation equipment. The act requires the GSA to work with electronics companies and representatives of disabled consumers in writing the guidelines. Unfortunately, federal agencies often are free to accept or reject the GSA's suggestions. The agency has until October 1988 to develop the guidelines for fiscal-year 1989, so the effect of the new law will be unclear for some time.

If federal agencies do comply with GSA-issued requirements, the effect on making technology more accessible to disabled consumers would be dramatic. The U.S. government is the world's largest buyer of office automation equipment. In 1986 agencies purchased $845 million in hardware, software, and related products. By 1991, according to one market-research firm, government agencies will spend $1.3 billion on office automation. Virtually every computer manufacturer would want to respond by making its products more accessible.

Some disabled consumers are working through large organizations such as the Boston Computer Society to pressure computer manufacturers to modify their equipment. These groups could extend the pressure to manufacturers of all kinds of commodity electronics. Such consumer activism could prove to be an important supplement to government regulation, and there have been some encouraging early results. IBM hastily redesigned one of its products after shipping the first units when it realized that the device could not be used by some blind people. Xerox has added sharp contrast to the lettering on its Marathon copiers to help people with poor vision read the controls. The company also elegantly designed paper trays so that people with severely limited hand dexterity can use them easily.

A disabled woman uses a special keyboard that helps prevent her from randomly touching keys she does not intend to press.

Another hopeful sign is the emerging dialogue among representatives of government, industry, and disabled consumers. In February of 1984, representatives of these groups met in the Indian Treaty Room in the White House to discuss what could and should be done to make computer hardware and software more accessible. Many of the companies that attended this meeting, including Apple, Honeywell, AT&T, and Digital, are examining their product lines to determine how to redesign the next generation. These companies will have to make such concerns an ongoing part of their work, since the pace of change in electronics is so rapid that efforts

Continued on page 72

PHOTOS: HUMAN RESOURCES CENTER; KURZWEIL

Skylines of Fabric

BY DOUG STEWART

THE oldest human-made shelter in the world—the tent—is making a comeback. Durable new materials and clever architectural schemes are freeing fabric structures from their traditional association with circuses and Boy Scout outings. A handful of designers even believe that permanent fabric roofs may one day be a common sight on American skylines.

Tents have long been fixtures of the Arabian landscape, so it's not surprising that the Saudis have commissioned the most spectacular fabric structure to date. Completed in 1981 and shading a full 105 acres of desert, the covering of the Haj Terminal at the Jeddah airport is the largest roof in the world. Its 4.6 million square feet of gleaming white fabric shelter the hundreds of thousands of Mecca-bound pilgrims who converge on the airport each year.

The Saudi government had plenty of money—back in 1981 at least—to spend on the detailed engineering studies that such experimental, one-of-a-kind structures require, and fabric turned out to be the perfect roofing material. First, Jeddah

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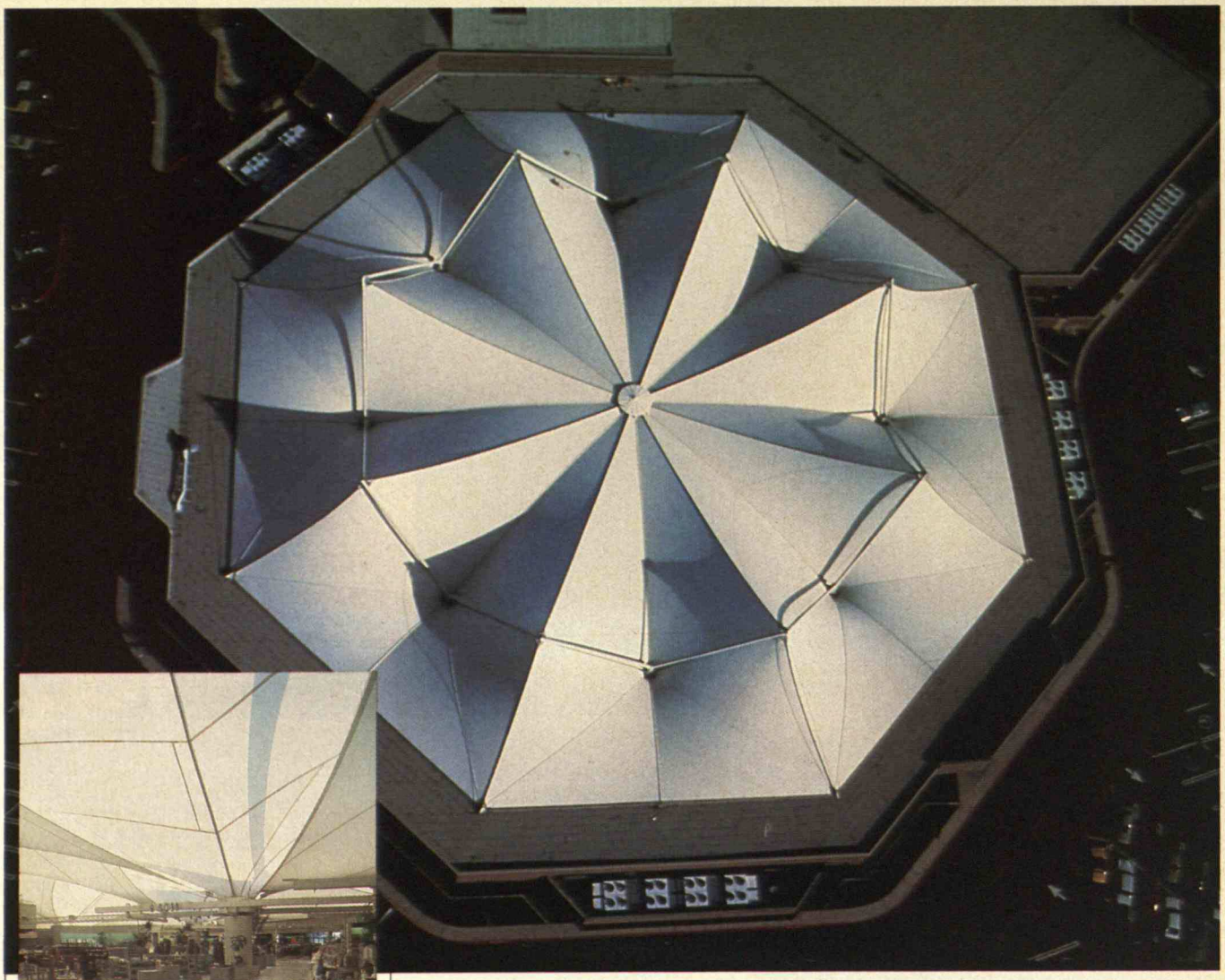
Built in 1985, the Riyadh International Stadium in Saudi Arabia is fabric architecture at its most dramatic. The roof, an undulating ring of 24 white fiberglass peaks, is large enough to shade 67,000 spectators from the sun (inset).

PHOTOGRAPHS: HORST BERGER PARTNERS



A structure with a fabric roof needs no artificial lighting during the day. The fabric also softens the sun's rays, creating a bright but shadowless ambiance. Above: The fabric roof of the F.I.S. department store in San Mateo, Calif., puts merchandise in its best light. Top: An aerial view of the roof shows its octagonal shape.

is warm and dry, so the roof's chief function is as a sunshade. The white fabric reflects many of the desert sun's rays, and warm air can escape through the openings at the top of the roof's 210 tent-like cones. Second, an airport roof need not provide privacy for occupants, accommodate electrical wiring, or support people on higher stories. Finally, Arab culture has accepted the tent as architecture for millennia. The Haj roof fits in perfectly in Jeddah.

To most Westerners, however, fabric seems too flimsy for permanent use. And by itself, it is. A loose expanse of cloth is as limp and worthless as a flag drooping on a pole. What makes a fabric roof strong enough to resist wind, rain, and snow is tension.

The Physics of Fabric

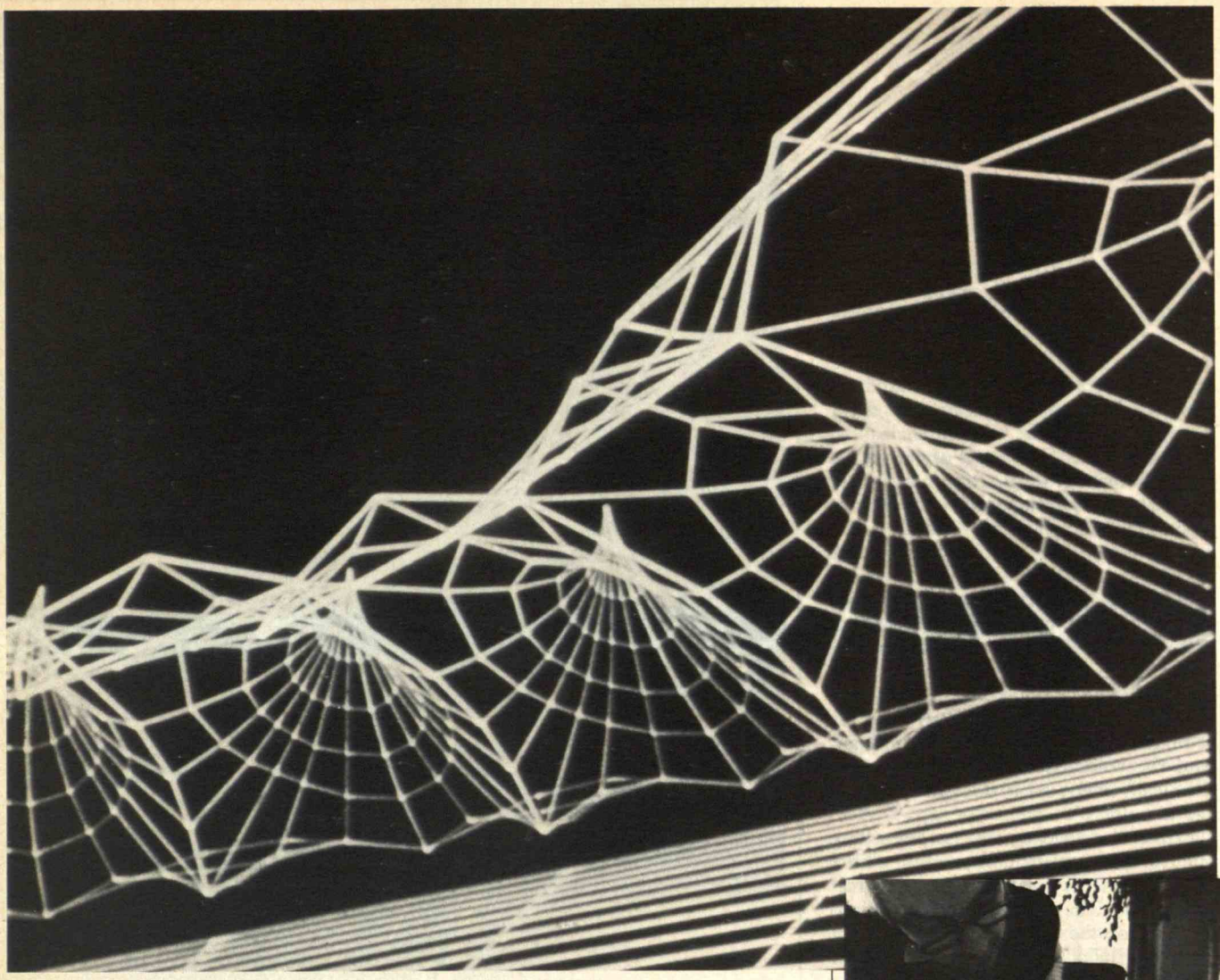
During installation, a tent roof is stretched and twisted between an assortment of fixed high and low points—masts, arches, cables, wall tops, and ground anchorages. This carefully calculated, continuous tightening, called "pre-stressing," forces the fabric into its designed shape. The taut surface must then endure the varying, day-to-day stresses of winds or snow. Opening an umbrella is a familiar example of pre-stressing. If the spokes do not pull the fabric snugly into place, it droops, flutters, and eventually tears.

As with an umbrella, tension alone is not enough to make a tent roof hold its shape reliably: curvature is also needed. Not just any curve will do, though. Every section of a tent roof is shaped like a horse's saddle, curving up in one direction and down in the other. You can make your own saddle surface by tacking three corners of a tightly stretched handkerchief to a board and pulling the fourth corner out and slightly up.

The opposing tensions bring each point of the fabric's surface into a fixed position, just as the opposing tensions of rigged stays make a sailboat's mast stable. The fabric doesn't sway in the wind or bow under a load of snow. The more pronounced the curvature, the stiffer the surface. Without curvature, even a tightly stretched surface will yield. That's why a drum vibrates when hit.

For the architect who's tired of the same

PHOTOGRAPHS: HORST BERGER PARTNERS



Computer graphics help fabric engineers visualize complex, three-dimensional shapes. Using data about the location of points on curves in space, a computer can draw a picture of a fabric roof (top). However, many designers, including fabric pioneer Horst Berger (above), work with stretched-fabric models to develop their initial ideas.

old box shapes, fabric's intriguing curves offer an escape. "The beauty of a fabric structure is that you can see where the stresses are, the way you can with a suspension bridge," says Horst Berger, a structural engineer who has pioneered the design of fabric structures. A fabric roof reveals the interplay of opposing tensions to anyone who looks upward. "With fabric," says Berger approvingly, "form *must* follow function."

Nevertheless, the ubiquitous curves in a fabric structure complicate the designer's task. Architects are trained to draw lines and angles using T squares and triangles. The hyperbolic paraboloids of stretched fabric defy such instruments. "Architects always come to me with straight lines," Berger says. "I always tell them everything must be curved."

Most of the tents used throughout history were neither highly tensioned nor highly curved. As a result, few could stand up to the forces of nature for long. Primitive nomadic tents, like the North American teepee, were often simply wooden frames draped with animal skins. On a grander scale, the Coliseum in Rome is thought to have sported a huge, removable cloth awning that was hung across a series of masts protruding from the tops of stadium walls. In later centuries, tents were sometimes spacious and elaborately furnished, yet they were still impermanent, sheltering military field commanders and traveling royalty.

Originally, tents were shaped like little houses, according to fabric architect Bill Moss of Camden, Maine. For instance, the traditional slab-sided tent uses fabric as a cheap substitute for a wooden roof and walls. "But when you have a flat surface on a tent, the wind will blow it down," says Moss, who now designs hardier tents for backpackers. Moss's own tents curve and twist like Chinese processional dragons.

Not all of today's fabric structures are highly curved. The balloon roofs of modern stadiums in the United States and Canada are relatively flat expanses of fabric kept aloft by air from electric blowers. These roofs are cheaper to design and build but they are not as aesthetically pleasing as fabric tents with graceful curves. Nor are they as durable.

Bringing the Outdoors In

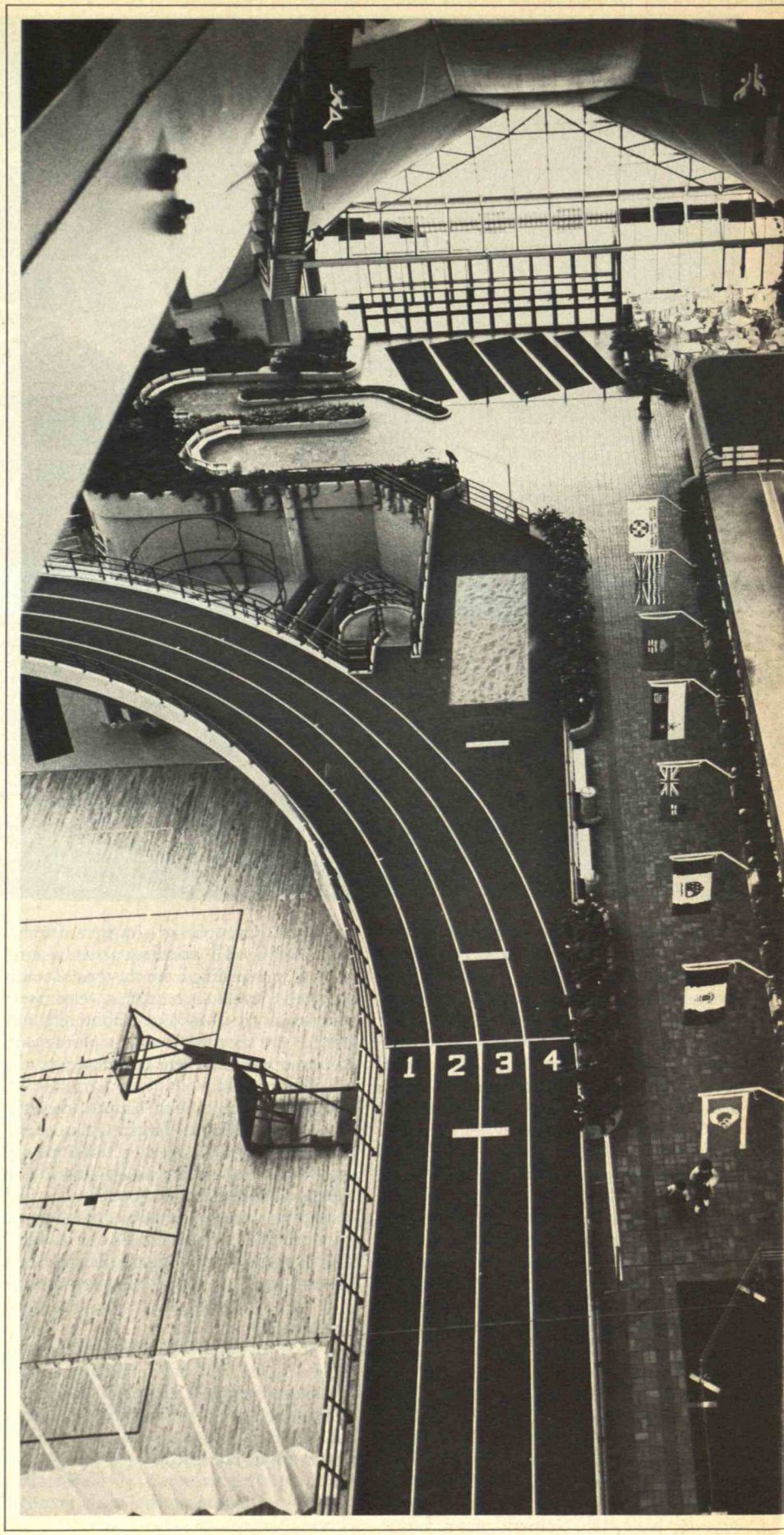
Efforts to exploit the physics of curvature and tension have certainly advanced the cause of permanent fabric structures. But new kinds of architectural fabrics have been even more important. In the old days, there was only canvas. Heavy and dark, it sagged, caught fire, and often leaked. Then came the first wave of large, so-called permanent fabric structures—a set of fanciful, vinyl-coated polyester tents at Japan's Expo 67 pavilion in Montreal. Vinyl, however, had its shortcomings: it smoldered when burned, and it stretched over time, creating wrinkles and sags. Prolonged sunlight made its outer surface sticky and hard to clean.

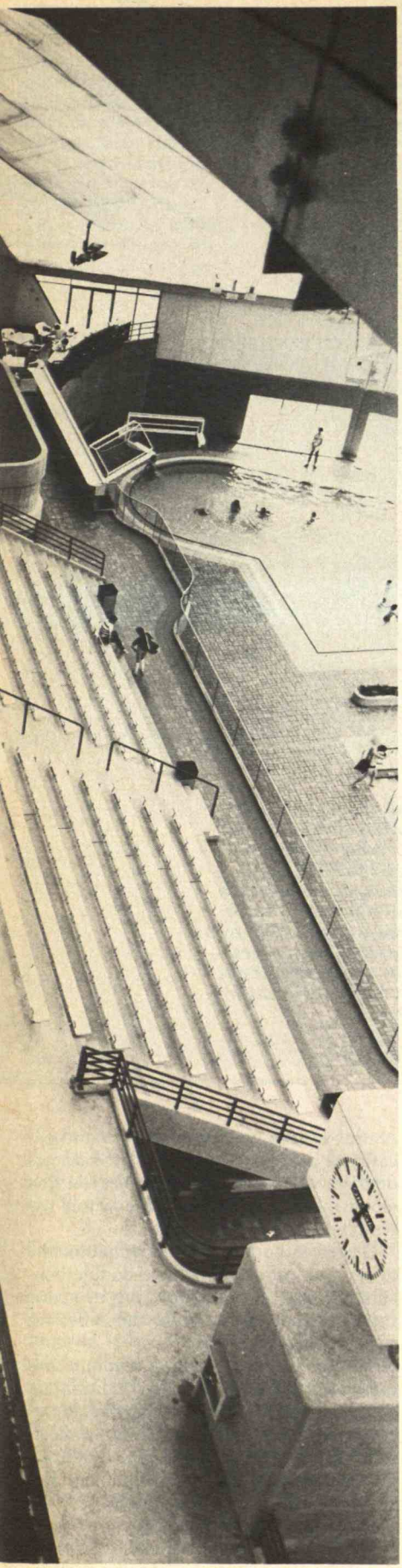
The fabric of today's large roofs is usually a Teflon-coated weave of fiberglass strands. Though pliable, it barely stretches at all. It won't burn. Rain washes it clean. And the translucent Teflon coating is chemically inert, so it does not corrode and discolor.

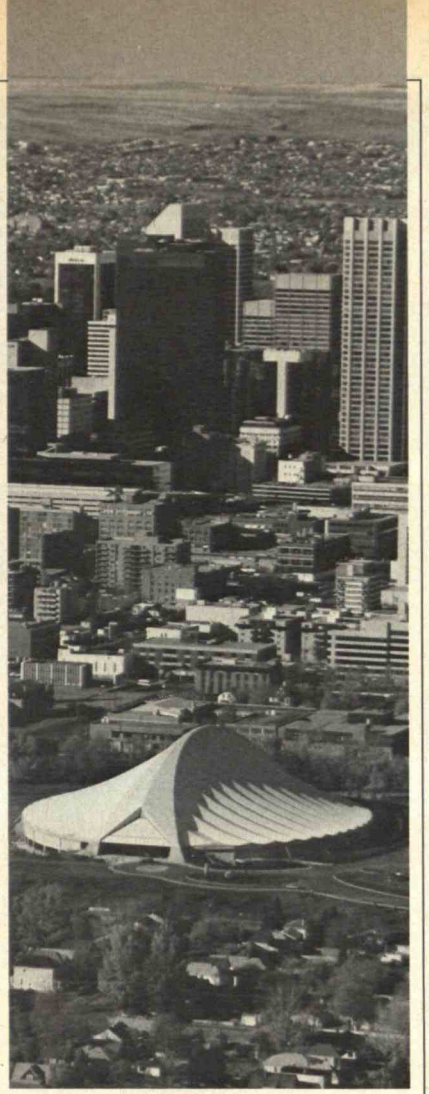
In fact, translucency itself is a key selling point. A stadium, mall, or pavilion with a fabric roof needs no artificial lighting during the day. The octagonal stretched-fabric roof of the F.I.S. department store (formerly Bullock's) in San Mateo, Calif., seems to put merchandise in its best light. The sun's rays are softened to create a bright but shadowless ambiance.

Translucent roofs can also give work spaces an open feeling. FTL Associates, a New York design firm, recently stretched translucent fabric canopies under the roof that shelters 25,000 feet of office space at Chicago's Bradford Exchange, which markets decorative ceramic plates. These canopies diffuse both artificial lighting and the sun from skylights. The result is a relaxed, outdoors-like setting—"except there's no wind and there's air-conditioning," says Tom Gradel of the Exchange.

Increased computer power has also been a boon to fabric structures. A curved expanse of fabric under tension is a complex system of forces. Tightening a cable here or lifting a mast there causes mathematical pandemonium. In the early 1970s, the design of the Munich Olympic stadium's tent-like roof involved as many as 200 workers at one time. Many of them spent weeks using hand calculators to determine how tightly to pull the cables and how sturdy to make the anchorages. (The roof was actually a covered mesh of crisscrossing cables, not a fabric surface, but the







Winters in Calgary, Alberta, are extremely cold. But the temperature of the Lindsay Park Sports Centre (left and above) is a steady 68° Fahrenheit in the gymnasium and 73° in the swimming and diving area. A roof with insulation sandwiched between two layers of fabric helps retain heat. Although not cheap, insulated fabric roofs are less expensive than conventional steel roofs because they are lighter. They can weigh one-thirtieth as much.

structural principles were the same.)

Today, fabric designers rely on computer-graphics programs to calculate tautness and shape. In many cases, crude tabletop models built with pins, glue, and swatches of panty-hose fabric are used only to please clients who still distrust images on a computer screen.

Computers were essential in designing the complex fabric roof of the 67,000-seat Riyadh International Stadium in Saudi Arabia. Built in 1985, the structure is architecture at its most dramatic. The 24 white fiberglass peaks that top it make an undulating ring 945 feet across.

Soaring Above the Crowds

In the United States, modern stadiums are much more likely to be covered by air-supported balloon roofs, which are less expensive. This form of fabric roof was pioneered by David Geiger, formerly Horst Berger's partner. Geiger, a structural engineer, designed the balloon roofs for the Metrodome in Minneapolis; the Silverdome in Pontiac, Mich.; the Carrier Dome in Syracuse, N.Y.; and B.C. Place, a sports stadium in Vancouver.

Geiger's balloons resemble huge, flattish pancakes. Saddle curves and internal supports are not needed because electric blowers keep the air pressure inside just a fraction of a percent above that outside. This props up the fabric and gives it enough stiffness to withstand wind, rain, and snow.

Unfortunately, those elements sometimes win out. Geiger's domes have deflated after quick, heavy snowstorms. However, the result in each case has been far short of calamity: collapsing fabric should never be confused with collapsing steel or concrete. In fact, had a football game been underway when the Silverdome deflated a few years ago, it probably could have continued, since the roof's lowest point was 100 feet above midfield. But part of the roof had ripped on a metal light-support tower, so a new roof was required, along with lower towers. The roof cost an extra $8 million and engendered lawsuits that are still winding their way through the courts.

Geiger says his latest air-supported roofs are designed to hold up under major snowstorms. If so, they should be ideal for stadiums. Though colossal, they are extremely light—as little as one-thirtieth the

PHOTOGRAPHS: L. WEBSTER/LIBRA PHOTOGRAPHIC

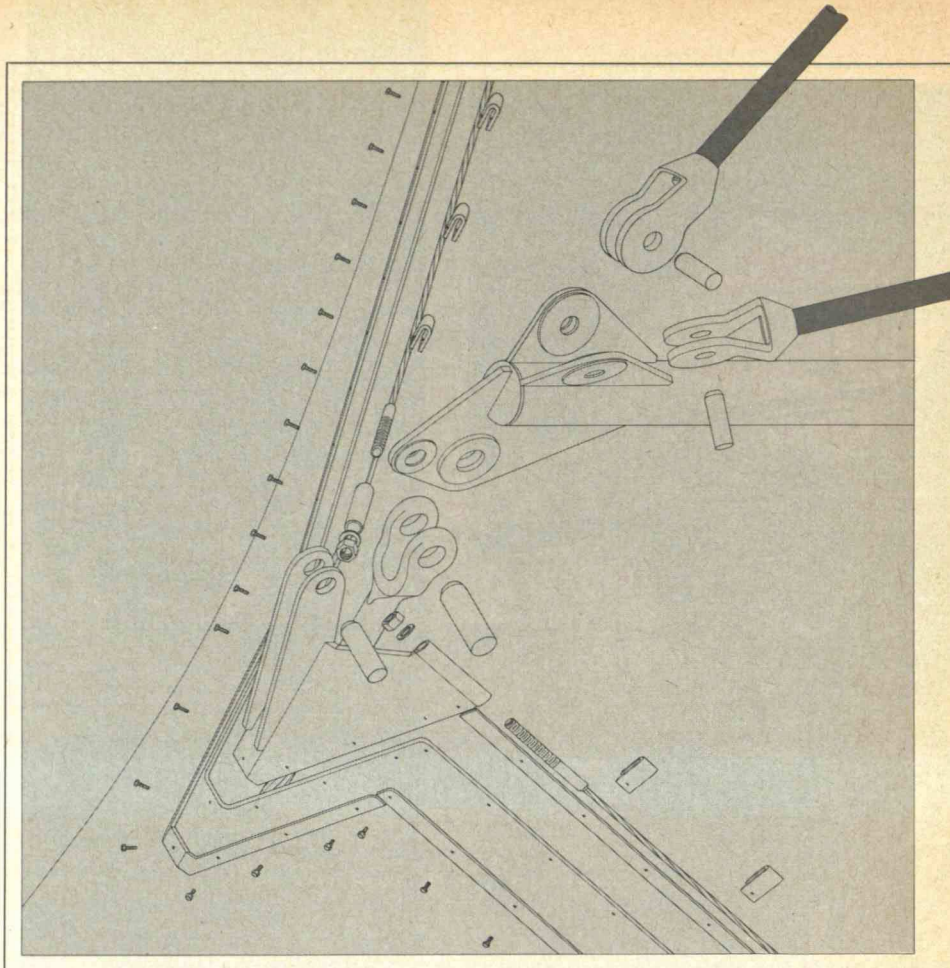
weight of a conventional stadium roof. According to Geiger and other fabric enthusiasts, this makes them less expensive overall. Money saved in construction more than makes up for whatever money may be lost on heating. The steel-topped Superdome in New Orleans, La., cost $140 million to build in 1975. That same year Geiger's Silverdome, with nearly 5,000 more seats, cost $55 million. His Carrier Dome cost less than half as much per spectator seat as the steel-roofed Astrodome in Houston, Tex.

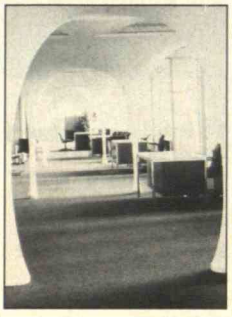
The Price of Being Different

Some fabric designers feel uneasy about any roof that needs electric blowers to stay in place. Large, unpressurized tent roofs do not need blowers, but designing their intricate curves is pricey even if computers are used. Mainly because of design expenses, the dramatic, translucent fabric roof of the F.I.S. department store cost more than a conventional flat roof would have. Even so, it is simpler and faster to install a large fabric roof than one of steel or wood, largely because fabric is flexible and lightweight. Erecting even the largest balloon roofs takes only about six weeks instead of six months.

For most architects, fear of the unknown is another major obstacle. Builders probably won't consider fabric roofs for supermarkets, gymnasiums, and schools until someone comes on the market with modular, snap-on sections. Moreover, the so-called permanence of fabric roofs is an open question. Manufacturers like to say these roofs can last "20-plus years," but the oldest one, at La Verne College in California, is only 13. No one disputes the fact that Teflon-coated fiberglass is tough under tension. A strand of fiberglass can resist a tug that would snap a strand of steel. Steel, on the other hand, can resist bending, folding, and mutilating. A fiberglass roof can be cut with a knife.

Fabric is also a lousy insulator. A single layer holds in heat as effectively as a sheet of plywood. When the climate is chilly, utility bills can soar—even if you don't need to turn the lights on during the day. Owens-Corning-Birdair, the leading manufacturer of architectural fabrics, has recently developed an expensive but workable alternative: a translucent sandwich. The outer layer is Teflon-coated fiberglass, and beneath it is a layer of woolly fiberglass insulation up to 16 inches thick.





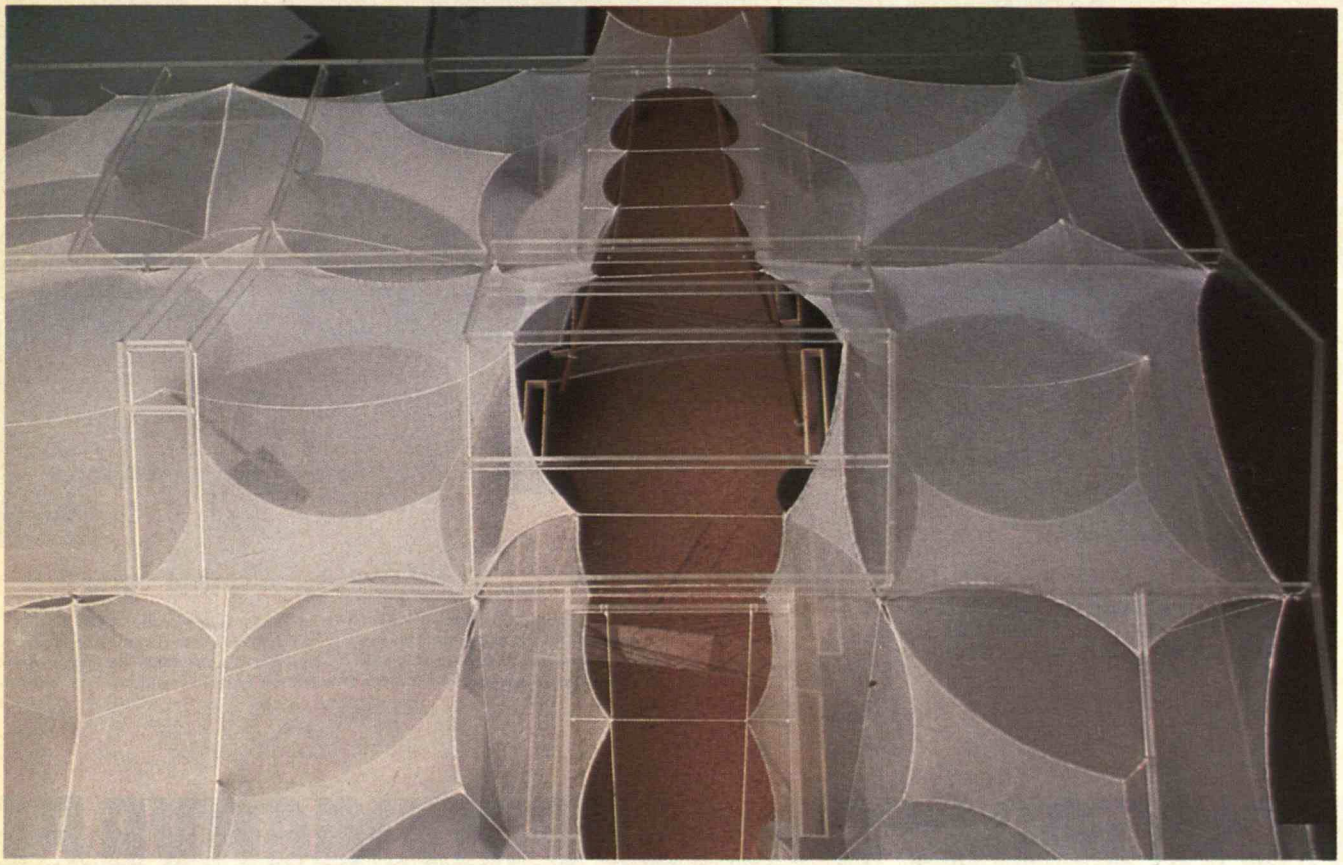
Undulating yards of stretched fabric can be used to partition large open spaces into private offices. Left: fabric creates arcades and vaulted chambers for an international furniture exhibit in Paris.

Several inches of dead air lie between the insulation and the inner layer, which is a plastic vapor barrier to prevent condensation. The sandwich both insulates and lets light through. Earlier insulated fabrics could do one or the other but not both.

In 1983 David Geiger used this new material for the roof of Canada's Lindsay Park Sports Centre in Calgary, Alberta, where sub-zero winters make insulation a must. Brenda Clarke, the center's general manager, says its annual utility bill is below that of a traditionally covered sports center nearby, thanks to sunlight hitting the roof. "This isn't a building, it's an environment," Clarke says. "It gives you the feeling of being outside." On dreary days, of course, that can be a disadvantage, as it is for structures with skylights. In Lindsay Park, electric lights are attached to a central arch to provide nighttime and occasional daytime lighting. Inflated domes often have lights hung from cables running along the underside, with the whole assemblage held aloft by blowers.

Geiger and other fabric champions like to say that fabric roofs have double benefits. Translucency reduces the need for furnaces and lights, while the reflective surface holds down the cost of air-conditioning. No hard-topped stadium has ever been built without air-conditioning, but theoretically a fabric-topped stadium could be. However, soon after the Metrodome's owners chose not to install any air-conditioning, they regretted it. "The Twins and their fans were boiled out the first year they had the new stadium," says Byron Engen, a heating and air-conditioning engineer for Owens-Corning-Birdair.

Translucent fabric can give work spaces an open, outdoorsy feeling. Right: FTL Associates, a New York design firm, recently stretched fabric canopies under the roof that shelters 25,000 feet of office space at Chicago's Bradford Exchange. The canopies allow sun from skylights to filter in. Below: A stretched-fabric model demonstrates the soundness of FTL's final design. Far left: A corner point of one canopy in detail. A steel plate connects the two cables that run along the fabric's scalloped edges. A series of rods and pipes attaches the plate to a slender column. This system allows the collected forces on the fabric to be passed along through the column. Only a few such columns are necessary to hold up the entire fabric assemblage.



"But that's not the fault of the roof. You put 40,000 people in a stadium, just the heat from their bodies will be more than you'll get from the sun."

Tents for the Future

Geiger's latest approach to large roofs is the cable dome, a refinement of an idea dreamed up by Buckminster Fuller. A cable dome's fabric top is supported by a complex web of tightly stretched cables that radiate from a central ring. To make the roof bulge like a dome instead of droop like a sack, the cables zigzag through arrays of metal bars. The bars themselves are suspended hundreds of feet in the air like candles on an invisible cake. The cables keep them in place.

Like a tent roof, a cable dome needs no blowers and can use heavy, insulated fabric. Like a balloon roof, it can cover large open spaces without the obstruction of masts or arches. And it won't collapse in snowstorms. Geiger has several cable domes in the works, including two stadium roofs for the 1988 Olympics in Seoul.

Geiger has other ideas for the more distant future. Perhaps most imaginative is his scheme for covering a mining town in the Arctic completely with a dome—creating a huge solar greenhouse. A permanent layer of sun-heated air at the top of the dome would keep the transparent, ultra-thin plastic skin fully inflated and keep the town warm.

Tent-maker Bill Moss's dream is to see one-story fabric structures accepted as permanent housing. As the swooping designs of Moss and others have demonstrated, fabric is sturdy and cheap enough to compete with steel, wood, and concrete for a variety of projects, big and small.

In the United States, a growing number of people live in Moss's mass-produced tents year-round. In most of these cases, however, the climate and culture is Californian. At last count, for instance, some 12 families live in fabric tents in the Sausalito area. But in most cases, building codes frown on residential tents.

More than restrictive codes or other practical drawbacks, the very *idea* of the tent has been blocking its widespread acceptance in the Western world. Conventional designers simply don't think fabric structures look like architecture. "To most people, tent is a dirty word," says Bill Moss. "We've got to change our whole image of what a tent is." □

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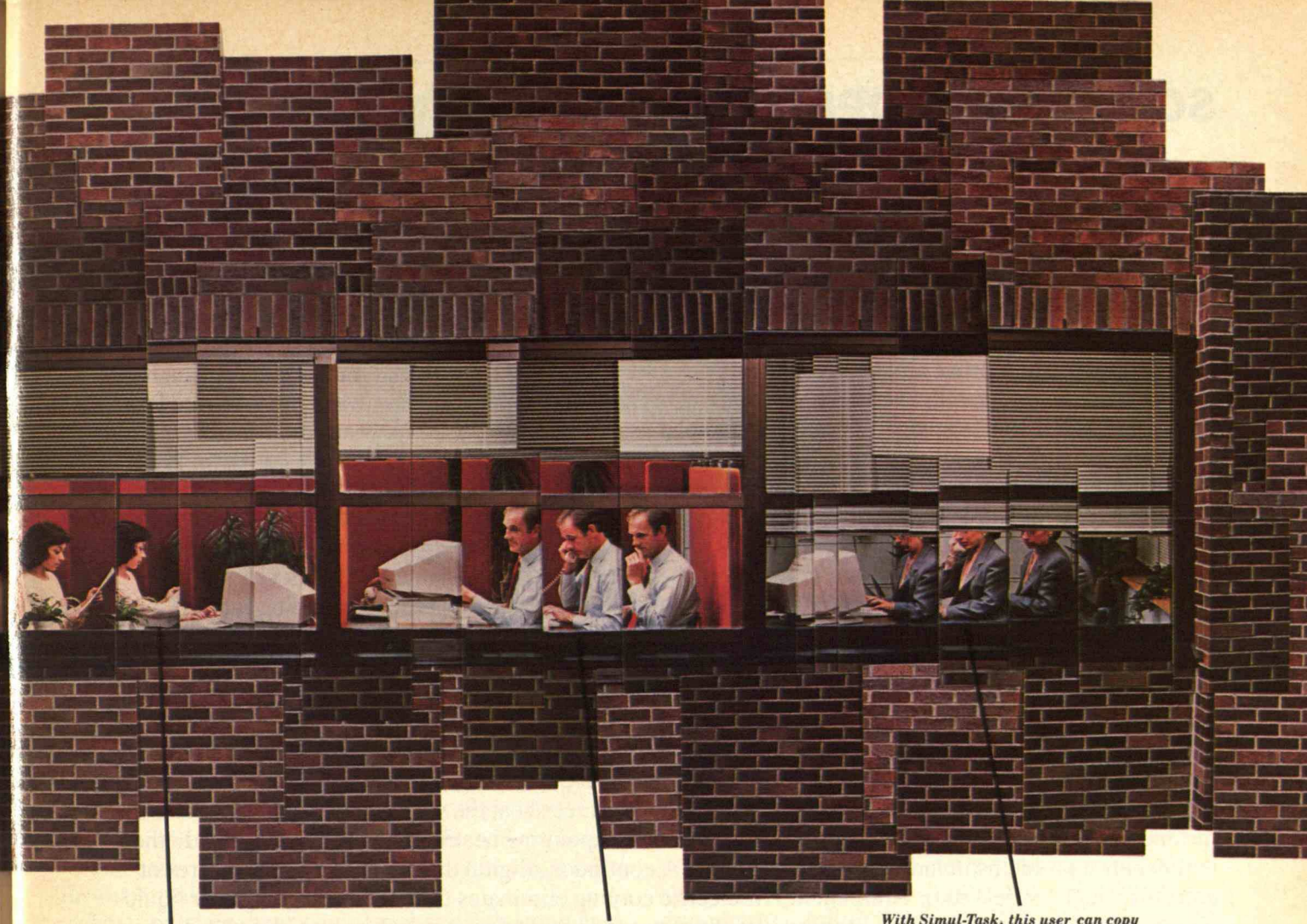

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Direct communication between South Pole scientists and the U.S. is possible now for the first time through ATS 3, the third Applications Technology Satellite. NASA's Goddard Space Flight Center in Maryland installed a satellite antenna system at the South Pole to send and receive VHF signals from ATS 3. After over 18 years in geosynchronous orbit—well beyond the design life of seven years—the Hughes satellite is one of the last to use the low VHF frequency. Depleted of its positioning fuel, ATS 3 drifts daily into tracking ranges of ground stations at the South Pole and at the University of Miami in Florida. Communications are available for about four hours a day. The Antarctic project is a joint venture of NASA, the National Science Foundation, and private industry.

A new infrared viewer combines numerical temperature readouts and thermo-electric cooling to spot heat leaks and other energy losses more efficiently. The device is the latest model of Probeye® viewers from Hughes. As all units in the line, the Model 699 viewer sees heat the way a camera sees light and instantly converts it to a visual image. It can be used for pinpointing heating and cooling leaks and other maintenance problems in industry and commerce. A continuous digital display shows temperatures of objects in degrees Celsius or Fahrenheit. All-electric cooling eliminates the need for argon gas or liquid nitrogen, thereby cutting weight, making it easier to use, and removing restrictions by airlines and other common carriers on transporting pressurized devices.

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CONTINUED FROM PAGE 41

Twentieth-century China seems to be having a love affair with technology just as nineteenth-century America did.

power and nuclear weaponry); some branches of the environmental and feminist movements; the "small is beautiful" and "stable-state" economic theories, as well as the quest for "soft energy paths" and "alternative (or appropriate) technologies."

Technocratic versus Social Progress

Perhaps this historical summary will help explain the ambivalence toward the ideal of progress expressed by many Americans nowadays. Compared with prevailing attitudes in the U.S. in the 1840s, when the American situation was more like that of China today, the current mood in this country would have to be described as mildly disillusioned.

To appreciate the reasons for that disillusionment, let me repeat the distinction between the two views of progress on which this analysis rests. The initial Enlightenment belief in progress perceived science and technology to be in the service of liberation from political oppression. Over time that conception was transformed, or partly supplanted, by the now familiar view that innovations in science-based technologies are in themselves a sufficient and reliable basis for progress. The distinction, then, turns on the apparent loss of interest in, or unwillingness to name, the social ends for which the scientific and technological instruments of power are to be used. What we seem to have instead of a guiding political goal is a minimalist definition of civic obligation.

The distinction between two versions of the belief in progress helps sort out reactions to the many troubling issues raised by the diffusion of high technology. When, for example, the introduction of some new labor-saving technology is proposed, it is useful to ask what the purpose of this new technology is. Only by questioning the assumption that innovation represents progress can we begin to judge its worth. The aim may well be to reduce labor costs, yet in our society the personal costs to the displaced workers are likely to be ignored.

The same essential defect of the technocratic mindset also becomes evident when the president of the United States calls upon those who devise nuclear weapons to provide an elaborate new system of weaponry, the Strategic Defense Initiative, as the only reliable means of avoiding nuclear war. Not only does he invite us to put all our hope in a "technological fix," but he rejects the ordinary but indispensable method of international negotiation and compromise. Here again, technology is thought to obviate the need for political ideas and practices.

One final word. I perhaps need to clarify the claim that it is the modern, technocratic worldview of Webster's intellectual heirs, not the Enlightenment view descended from the Jeffersonians, that encourages the more dangerous contemporary fantasies of domination and total control. The political and social aspirations of the generation of Benjamin Franklin and Thomas Jefferson *provided tacit limits to, as well as ends for, the progressive vision of the future.* But the technocratic version so popular today entails a belief in the worth of scientific and technological innovations as ends in themselves.

All of which is to say that we urgently need a set of political, social, and cultural goals comparable to those formulated at the beginning of the industrial era if we are to accurately assess the worth of new technologies. Only such goals can provide the criteria required to make rational and humane choices among alternative technologies and, more important, among alternative long-term policies.

Does improved technology mean progress? Yes, it certainly *could* mean just that. But only if we are willing and able to answer the next question: progress toward what? What is it that we want our new technologies to accomplish? What do we want beyond such immediate, limited goals as achieving efficiencies, decreasing financial costs, and eliminating the troubling human element from our workplaces? In the absence of answers to these questions, technological improvements may very well turn out to be incompatible with genuine, that is to say *social,* progress. □

CONTINUED FROM PAGE 59

Workers who use their hands for other tasks will find computers that recognize the human voice invaluable.

to make one product more accessible would have little permanent effect.

The costs of such efforts will vary widely but need not be severe. Programming a keyboard to accept sequential keying costs nothing. A chip that allows a computer to give voice output costs only about $5. Writing code to instruct hardware and software to send information to that chip may be a lengthy and costly procedure, but possibly only the first time each manufacturer makes the effort.

Yet industry has begun to realize that equipment developed to meet the special needs of disabled consumers is more attractive and practical for everyone. Companies are working to develop computers that understand human speech not in response to the needs of people who are deaf and blind: they are doing it because many executives are reluctant to use keyboards. Workers who use their hands for other tasks, such as quality inspectors on factory assembly lines, will also find computers that recognize the human voice invaluable.

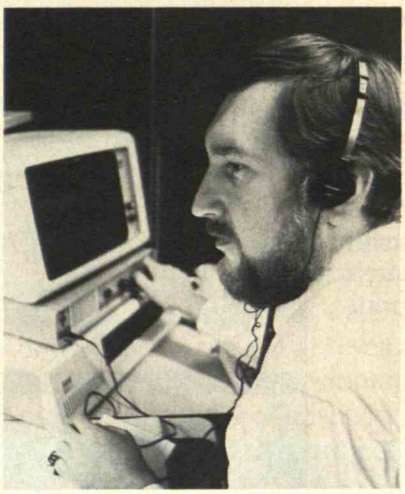
Similarly, the idea of transparency is attractive to many nondisabled users who want to be able to link hardware and software from different vendors. For example, companies are trying to develop transparency for "local area networks": office systems in which a series of computers, printers, and other devices work together.

The idea of redundancy also appeals to many nondisabled users. Some people prefer to listen to information rather than to read it. Some like to use a mouse while others shun the rodent. Some people prefer the mouse for spreadsheets but find it awkward for word processing. Redundancy allows users to choose different options in different situations. The concept is simply an extension of user friendliness: it permits users to "do it their way."

The Promises

Designing electronics to accommodate diverse needs will allow tens of millions of disabled Americans to participate fully in community life. The personal computer will be able to see for blind people, remember for those who are retarded, hear for those who are deaf, and move for individuals with physical limitations.

Computers that can recognize the speech of different people—the next major advance in making this technology accessible—will revolutionize the lives of many disabled people. These machines will probably use the new Intel 80386 chips, which partition vast amounts of memory so that the computer can run several software programs at once (called "multi-tasking.") These chips are expected to allow programmers to design software that understands tens of thousands of words, allowing desktop computers to print what they hear as they hear it. This will enable deaf individuals to talk on the telephone, participate in meetings, even overhear gossip. The machines will also enable blind and physically disabled people to enter words and data without keying.



Peter Slowkowski, a systems analyst for Nynex Corp. who is blind, uses a voice synthesizer to work at his personal computer. An emulator must be installed in the computer to allow output to go to the synthesizer. The emulator often has to be custom-designed for each computer model because there is no standard PC configuration now in use.

Such speaker-independent systems are probably still five to ten years away. IBM's experimental Tangora system now recognizes thousands of words and displays them instantly on the screen, but it and other such systems can understand only the voice that trains them. Commercial speech-recognition systems now cost about $7,000 to $9,000, but as with all other electronics, the cost will probably drop by about 20 percent a year as they are mass-produced.

There will always be a need for special computer components and software, just as accessible buildings do not meet the needs of all disabled people. Individuals who are both blind and deaf and many who are retarded, for example, will need extraordinary measures to permit them to use electronics in everyday life. But these exceptions will be relatively few. When society makes a commitment to making new technologies accessible to everyone, the focus will no longer be on what people cannot do, but rather on what skills and interests they bring to their work. That will be as it always should have been. □

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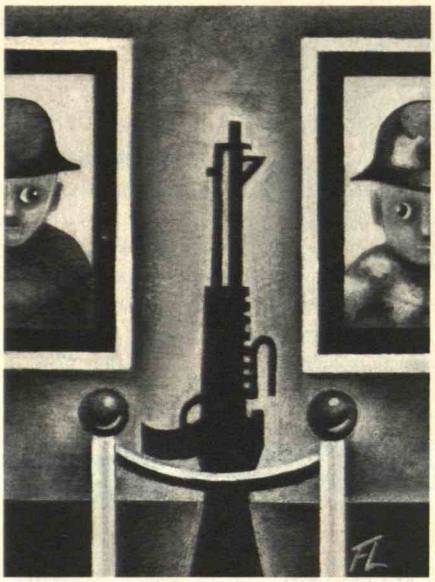
Reviewed by William Rosenau



Most historians consider the cotton gin, the assembly line, and even the washing machine as legitimate items for inquiry. But military technology is a different matter. Most historians would sooner join their local chapter of the National Rifle Association than study the development of the bayonet, flamethrower, or bazooka. This attitude is partly due to the widespread if unspoken belief that anyone who studies military technology is somehow pro-war. And of course, weapons are simply distasteful objects. The result of this neglect is that we may know more about the history of air conditioners than about the conditions that gave rise to the Colt .45 automatic pistol—a revolutionary weapon used by millions of U.S. officers in four wars.

In *The Social History of the Machine Gun,* first published 10 years ago and recently reissued, John Ellis makes an exception to this rule. "Guns, like everything else, have their social history," writes Ellis: they affect the conduct of warfare and reflect the role of the military in the societies that use them. Ellis offers some important insights into how the machine gun—the first real weapon of mass destruction—was developed and adopted by the armed forces of Western Europe and the United States. His primary interest is to show why military leaders were reluctant to accept the weapon even after the technology was perfected during the second half of the nineteenth century.

Before that time, the machine gun was a technological impossibility. Europeans had dreamed for hundreds of years of a weapon that could spew out a hail of bullets, but no metals were available to create a gun barrel that could withstand a high rate of fire. Even so, visionaries continued to try to design weapons to fire bullets in rapid succession. In 1663, an inventor named Palmer presented a paper to the Royal Society in London describing a gun that used the force of recoil and gases escaping from the barrel to discharge and reload. However, Palmer was about 200 years ahead of his time: no machines had been invented that could bore the gun chambers to trap all the gases, and that could make high-quality copper and brass bullet casings that wouldn't jam.

Little real progress was made until the middle of the nineteenth century, when American Richard Gatling perfected a crank-operated gun capable of firing 200 rounds per minute. In 1884, Hiram Maxim, another American, developed a weapon that fired bullets as long as the trigger was pulled, making it the first truly automatic gun.

Ellis shows that the machine gun was a product of conditions that existed only in the United States. The U.S. machine-tool industry was more advanced than its European counterparts and so was capable of producing the weapon. Also, the Civil War created a demand for weapons that could kill large numbers of soldiers rapidly. Both sides pitted all their industrial and military resources against the enemy and raised mass armies of recruits and conscripts—it was the first truly modern war. Moreover, American military leaders, unlike European officers, were much less hidebound in their beliefs about how a war should be fought and were therefore more receptive to new military technology. Machine guns were not widely used during the Civil War, but by 1866 the U.S. Army decided to officially adopt Gatling's weapon.

The situation in the Western European armies, in contrast, was one of unremitting hostility toward the new weapon. The officer corps of England, France, and Germany were dominated by the aristocracy and the gentry throughout the nineteenth and well into the twentieth centuries. Factories and machines were a threat to these men, writes Ellis, "a symbol of the new world in which their old dominance and self-confidence was being undermined." These officers' conception of war was firmly rooted in the past—one that included the bayonet, lance, cavalry charge, and frontal assault, and where the enemy's will to fight was crushed by the pluck and élan of the attacking force. Thus the officer corps refused to acknowledge the gun's deadly effectiveness even though it was repeatedly proven by European colonists in Africa and Asia. The officers thought that the gun dehumanized both its operators and its victims, "mowing men down like rats before a hosepipe," writes Ellis.

This contempt for the machine gun carried over into the First World War. When it began, the entire French Army could muster no more than 2,500 of the weapons, the British had no more than 2 per battalion (about 1,000 soldiers), and the Germans, though marginally more accepting of the technology, had roughly the same proportion of guns to infantry. The Americans also faced a shortage of these weapons when they entered the war, but by 1918 their monthly output of machine guns was almost three times greater than that of the British.

As the war dragged on, the troops using the gun demonstrated its murderously effective firepower over and over again. Frontal assaults on positions defended with the weapon became suicidal, and in combination with the trench it made the cavalry a costly anachronism. On the first day of the battle of the Somme, for example, two British battalions were almost completely wiped out within three minutes by a single well-placed machine gun. Yet the officers continued to resist the idea of making it the foot soldier's most important weapon.

By the war's end, the European officer corps had grudgingly accepted the machine gun as the decisive weapon in the conflict. But ironically, by 1918 the gun had lost its utility as an obstacle to frontal assaults. A new invention, the tank, could shield advancing troops from the machine gun's fire. Although the tank was not perfected in time to play a major role in the war, some European soldiers realized that it would render trench lines and other for-

ILLUSTRATIONS: FRED LYNCH

The orchestra members panicked when they realized they could barely hear their neighbors.

tifications obsolete. Armored mobility—the kind introduced by the Germans in their *Blitzkrieg* operations against the French in 1940—became the new decisive factor in warfare.

Ellis concludes rather pessimistically that the machine gun, tank, and other modern weapons have done precisely what the nineteenth-century officer corps feared: they have dehumanized warfare. "The quality of a country's weaponry and the capacity of its industrial output became the determinants of success, rather than any will to win," he writes. Yet as the United States learned in Vietnam, mere hardware and sheer firepower do not guarantee the success of a military operation. The services, especially the army, are rediscovering the importance of leadership, morale, and other intangible factors affecting the outcome of military conflict. It is undeniable that warfare has become increasingly automated, but it is wrong for Ellis to claim that "men are nearly helpless bystanders" on the battlefield. □

WILLIAM ROSENAU, formerly an intern at Technology Review *and an editor at* Military Logistics Forum, *is a student at Magdalene College and chairman of the Cambridge University Strategic Studies Group.*

Creating Great Concert Halls

Buildings for Music
by Michael Forsyth
M.I.T. Press, $45

Reviewed by Norman C. Pickering

Long ago I was a member of an orchestra that spent part of every season on tour, playing concerts in a different city each night. I can still recall the exhilaration of playing in an ideal acoustical space and the terror of having to perform in a bad one. Most halls were satisfactory, but there were two nightmare experiences that I shall never forget.

In one university city, the only space large enough for the expected audience was the athletic field house, which contained a quarter-mile track, thousands of feet of bleacher seats, and nothing else. Reverberations in this monstrous place

lasted at least four seconds, so every pause in the music was filled with a replica of what had just gone before—to devastating effect. Our soloist was Sergei Rachmaninov, who was making one of his last public appearances, and his distress was painfully obvious. Any attempt at subtlety in his performance was hopeless.

Another tour brought us to Chicago, where we gave a concert in the famous Auditorium designed by Dankmar Adler and Louis Sullivan for many different uses. Members of our orchestra began to panic during the performance when they realized that they could barely hear their neighbors, to say nothing of musicians in the other sections. Because the enormous volume over the stage was filled with scenery and backdrops suspended on ropes and pulleys, and there were no sidewalls nearby, little sound was reflected back to the orchestra—with a consequent loss of ensemble. Had the program not been completely familiar to every musician, the concert would have been a disaster.

In *Buildings for Music,* Michael Forsyth presents a learned review of the development of environments for the performance of great music, and the effect of those places on the music itself. He relates the process whereby musical performances, formerly restricted to the province of nobility, became available to the public beginning in the seventeenth century. These changes stimulated the evolution of concert halls and opera houses. This process continues today as architects try to accom-

CONTINUED FROM PAGE 75

modate the tastes of a public conditioned by recordings and television to experience a concert as if sitting in the best seat in the house.

Forsyth notes that concert hall requirements have also changed radically since World War II owing to stricter fire regulations (more than 1,000 halls burned during the nineteenth century), the need for better isolation from outside noise, and the need to accommodate larger audiences to defray the enormous costs of maintaining symphony orchestras. And ever higher construction costs have forced architects to invent new ways to enclose space both economically and attractively.

Forsyth's simple and logical explanations and the book's beautiful color illustrations help the reader understand the complexities of acoustics and the methods architects have devised to deal with these problems. In good halls, sound direct from the source reaches the listener first, followed quickly by reflections from walls and ceiling. These reflections must be diffused and overlapped so as not to create echoes but rather to reinforce the original sound. Forsyth dispels some of the myths that still circulate among performing musicians, such as the idea that wood walls and floors are essential for good sound quality. Fireproof materials such as stone, concrete, and plaster can be used to create ideal acoustical spaces if designers give proper attention to the way sound is reflected from these surfaces.

Most concert halls built today are too large to effectively control reverberation time: the echoes go on forever. Small groups of musicians cannot perform to good effect in such vastness. Nor can any one hall be designed to accommodate all uses ideally. Designers have responded by adding power-operated ceilings that drop over the upper balconies and part of the orchestra, simulating a smaller hall when needed. Architects may also design large halls to be acoustically "dead," using hidden loudspeakers to increase reverberation electronically. And designers often use fabrics and metal forms instead of the more expensive marble statues and plasterwork of bygone years to create texture and visual interest, as well as to assist in diffusing sound.

Concerts in halls where the masterworks of immortal composers were first performed reveal why these works were written as they were. For example, the organ works that Bach composed during his early years in Weimar and Cothen from 1717 to 1723 are much more florid than those composed at the Thomaskirche in Leipzig from 1723 to 1750. The larger Thomaskirche had a much longer reverberation time than the smaller buildings in which Bach began his career, and thus required slower harmonic changes and more moderate speeds to avoid a cacophonous jumble of sound. Bach's chamber works, on the other hand, are replete with virtuoso passages that can be heard clearly only in rooms with the intimate acoustics for which they were designed.

The scope of Forsyth's book is so broad and his text so informative that it gives readers a feeling that they could design the ideal music room, or at least correct problems in existing ones. Readers will also gain the near equivalent of visiting the world's most famous concert halls, including those that, sadly, no longer exist. □

NORMAN C. PICKERING, inventor of the stereo phonograph cartridge and formerly acoustical consultant to conductor George Szell, is working on ways to improve the acoustics of violins.

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will foreign investors be able to repatriate profits? Will they be allowed to convert income from rubles into foreign currency to import needed components? Will foreign owners be able to hire, fire, and discipline workers? Who will determine pricing inside the Soviet Union and how will the costs, including wages, be set?

These are all delicate issues that the Chinese, in their push for economic reform, still have not solved. Until they are settled in the Soviet Union, relatively few in the capitalist world may be willing to risk investing there. Moreover, unlike the Chinese, the Soviets do not have an overseas Russian community that is willing to involve itself as the overseas Chinese are.

The Soviets are likely to be equally frustrated by what happens once the Ministry of Foreign Trade's monopoly is broken. Based on what has happened in Hungary and China—which tried similar tactics—the Soviets may well find that allowing individual enterprises to import on their own will result in a chaotic proliferation of technology. The Soviets have already discovered that even with the Ministry of Foreign Trade's monopoly, little of the electronic equipment they have purchased, including computers, is compatible. If the Soviets could not even ensure computer compatibility when the Ministry of Foreign Trade had a monopoly, it is hard to see how they will do any better when 71 industrial enterprises can decide what to import on their own.

The Soviets are also likely to discover that such enterprises, finally freed from severe restrictions, will import so much new machinery and consumer goods that the balance of trade will dip too heavily toward imports. The state may be forced to step in again and restrict access to hard currency and loans from the West.

Gorbachev is to be applauded for facing up to the inevitable. Sooner or later he and his colleagues will have to plunge into the world marketplace. However, they must recognize that upgrading Soviet technology will take time, patience, and an initial increase in their imports and foreign debt. They must also realize that joint ventures will almost certainly not solve their problems with innovation and productivity; that will require even more fundamental changes in the Soviet economic system. The question now on the table is whether the Soviet dogmatists who oppose even the minimal reforms made so far will be patient enough for Gorbachev to obtain the results he needs. □

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Waiting for the Next Big Earthquake

Earthquake engineering has made substantial advances in the last 50 years, but now that progress has slowed. The field is in a holding pattern that may persist until the country's next major earthquake focuses attention on deficiencies in the research and building programs of the past two decades, says Robert V. Whitman, professor of civil engineering.

Among a half-century of achievements listed by Whitman at a national earthquake conference in Charleston, S.C., late last year:

☐ Earthquake-resistant skyscrapers. Whitman sees "clear evidence that modern buildings designed with sound earthquake engineering principles perform very well during severe shaking."

☐ "Societal lifelines"—highways, bridges, and utilities—that resist earthquake damage. "Industrial facilities that have been designed to withstand ground shaking—and this is particularly true of nuclear power stations—have performed very well."

☐ Greater awareness and understanding of earthquakes among engineers, public officials involved in mitigating earthquake hazards, and the public at large.

☐ "Enormous strides" in understanding the behavior of dams during earthquakes.

☐ Development of an effective network of seismographs to support research and early warning.

☐ Adoption of effective building-design codes by many cities in earthquake zones.

Whitman also points to some important unfinished tasks. Dangerous buildings still standing in earthquake zones should be dismantled. The effort to develop a model code covering the construction of earthquake-resistant structures has been compromised by "pressuring and dealing by special interest groups," he says. Post-earthquake studies have fallen victim to the competition among researchers to be first on the scene of a disaster, resulting in a massive literature that hides key data and important lessons. Moreover, funding for fundamental research has become harder to obtain, leaving crucial problems unstudied. One example of the latter, says Whitman: the need for accurate models for the behavior of structural materials under repeated loadings.

A "Bauhaus festival" in Boston this winter brought a major exhibition of the work of this influential German design school to the M.I.T. Museum. Included was this floor lamp (1923) by Bauhaus artist Gyula Pap.

Ceramic Bottleneck

A "Catch-22" is preventing the development of high-temperature ceramic rotors for automobile turbochargers, say three members of M.I.T.'s Department of Materials Science and Engineering.

Today's metallic rotors of high-temperature superalloys would be no competition for the ceramic parts envisioned by researchers Elaine Rothman, Joel Clark, and H. Kent Bowen. Rotors made of silicon nitride would be lighter. They would operate at higher temperatures, increasing engine efficiency and economy. And they would probably be lower in cost.

But automakers are unwilling to invest in the redesigned turbochargers that ceramics would require until they can be assured of reproducible, reliable rotors at reasonable cost. And the quality and cost of mass-produced ceramic rotors can't be determined until commercial-scale, high-technology production facilities are available. The M.I.T. team insists that investment would pay off: ceramic rotors that met automakers' needs could command a $40 million market by the year 2000.

Retinal Cancer Gene

The gene responsible for retinoblastoma, a rare, often hereditary cancer of the eye, has been isolated by a team from M.I.T.'s Whitehead Institute for Biomedical Research and the Massachusetts Eye and Ear Infirmary.

The achievement will lead to extremely accurate prenatal diagnosis of the disease—and perhaps to treatment in advance of birth. But it has greater significance because the gene induces tumors in a way radically different from previously known cancer genes. Thus the research adds what Richard Saltus of the *Boston Globe* describes as "an important new dimension to the understanding of how normal cells can be transformed into tumor cells."

The Whitehead Institute researchers include Stephen J. Friend, Rene Bernards, Snezna Rogelj, and Robert A. Weinberg; those at the Boston Eye and Ear Infirmary are Joyce M. Rapaport, Daniel M. Albert, and Thaddeus Dryja.

Seeking Information Instead of Weapons

Jerome B. Wiesner, president emeritus of M.I.T., has proposed an independent, nonaligned International Arms Verification and Study Center to promote international peace.

The center would help stem the arms race and reduce the danger of war in two ways:

☐ By studying arms-control issues and verification technology, training experts in these fields, and disseminating arms-control information.

☐ By using its expertise to monitor nations' adherence to agreements covering the deployment and testing of nuclear, biological, and chemical weapons.

Wiesner envisions an organization of 200 to 300 people that would design and use its own networks of seismic detectors and reconnaissance satellites, provide inspection teams, and perform research on both hardware and policy. Its annual budget would be up to $20 million. Initial funding of less than $10 million would provide for a start-up staff of 60.

The goal is simply expressed, he says: "Build a common security system by substituting information for weapons."

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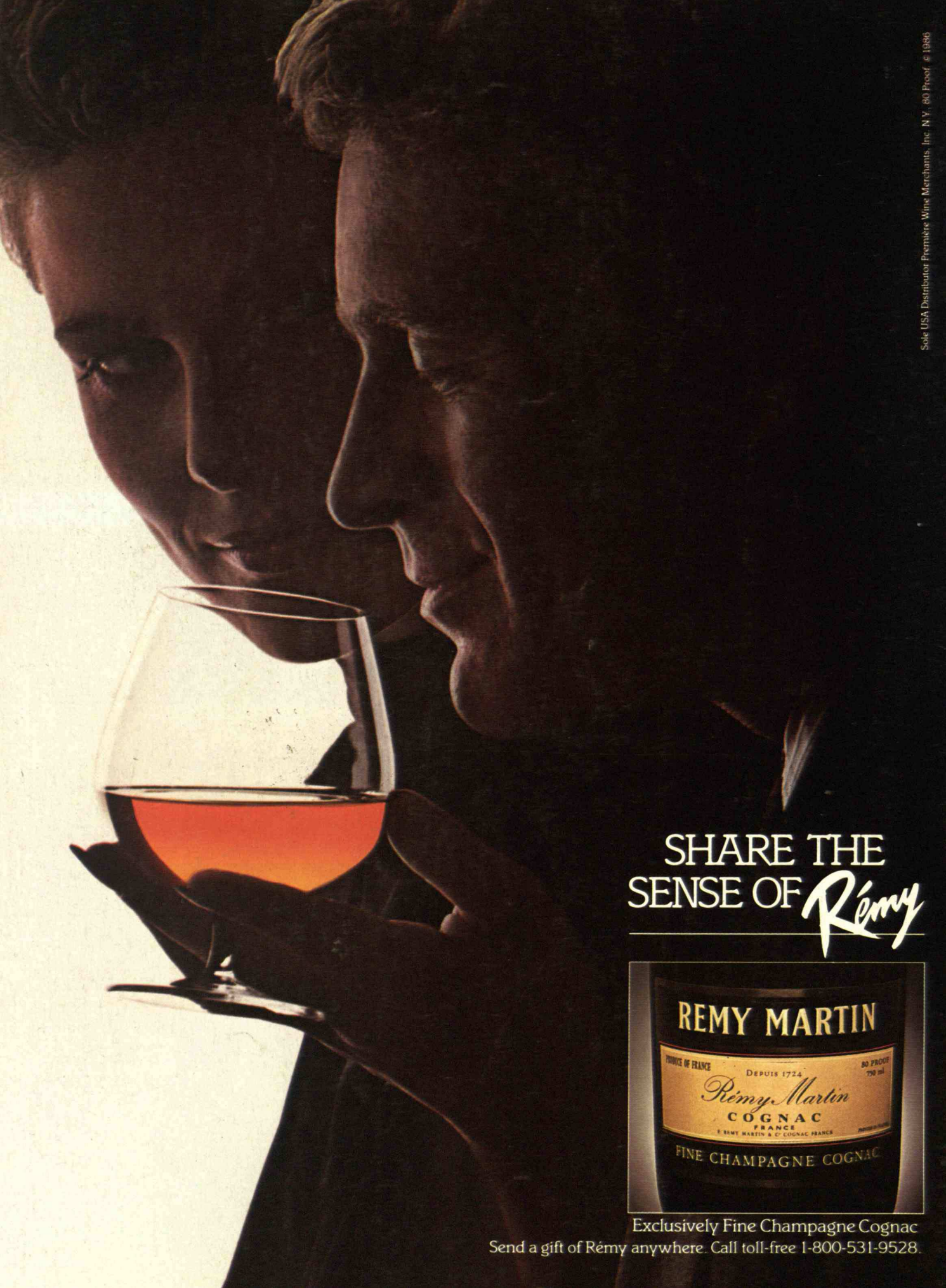

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